Teaming up for learning

Jos Fransen

TEAMING UP FOR LEARNING

Team Effectiveness in Collaborative Learning in Higher Education

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CHAPTER 1

Introduction

This chapter deals with the motivation for this research project on team effectiveness in collaborative learning in higher education, the argumentation for the methodological choices, the research questions that have been addressed, and it offers a preview of the studies that were carried out.

Introduction

The use of collaborative learning is often based upon the social-constructivist paradigm that students should become involved in a process of knowledge construction through discussion, debate or argumentation, which will result in deep learning, understanding, and ultimately conceptual change (Bereiter, 2002; Bruffee, 1993; Geelan, 1997; B. Smith, 2002). Within this paradigm, learners working with conceptual artifacts on the basis of a learning assignment with built in interdependency is considered conditional for meaningful participation in knowledge construction activities (Blumenfeld, Marx, Soloway, & Krajcik, 1996). Learning-teams that collaborate with the shared intention of achieving deep learning and conceptual change are considered to be effective learning-teams (Salomon & Globerson, 1989).

However, learning-teams may not be effective or may be less effective than they could be for a number of reasons. Learning-teams, for example, have to develop as a team to become effective, similar to teams in work settings. This will probably be even more important for learning-teams in the context of higher education, since these teams are usually asked/required to solve learning tasks in the form of complex problems which resemble the reality of project teams in organizational settings. Team effectiveness in this perspective is not only expressed by the quality of team results, but also includes the quality of the team's performance, as well as the perceived satisfaction of the needs of individual team members (Hackman, 1990). For learning-teams in the context of higher education, this implies that team members are satisfied with the quality of the team results as well as the quality of team collaboration leading to these results.

Research on the effectiveness of learning-teams is limited and most of what is known about variables mediating learning-team effectiveness stems from research on team performance and team effectiveness in organizational settings. Research on effects of team composition on the interaction between the team members of learning-teams, and therefore on team effectiveness, show a variety of results. Team formation based on characteristics such as learning strategies has either proved not to be effective (Tongdeelert, 2003; Webb & Palincsar, 1996), or only partly effective when specific aspects of learning styles and/or when students collaborate in pairs are con-

sidered (Alfonseca, Carro, Martín, Ortigosa, & Paredes, 2006; Paredes & Rodriquez, 2006). The fact that learning styles are defined and operationalized in many different ways complicates the process of grouping learners for collaborative learning (Sadler-Smith, 1997). Research also shows that cognitive ability of team members positively affects team learning (Ellis et al., 2003), but learning-teams in higher education are usually not composed on the basis of the students' cognitive ability. Things that do tend to increase the effectiveness of learning-teams are, for example, the monitoring of group interactions (Hare & O'Neill, 2000; Janssen, Erkens, Kanselaar, & Jaspers, 2007; Sangin, Molinari, Nüssli, & Dillenbourg, 2011), the enhancement of collaborative learning through transactive peer tutoring (King, 1998) or interactive technologies (C. Jones, Connolly, Gear, & Read, 2006), the scripting of collaboration (Ingo Kollar, Fischer, & Slotta, 2007), and the assignment of functional roles to team members (Strijbos, Martens, Jochems, & Broers, 2004). Learning-team performance and effectiveness increase when the students use higher level cognitive skills, which are mediated by the group composition with regard to the motivation and the self-efficacy of the group members. This has been shown to be true for assigned teams, at-random formed teams and student-led formed teams (Wang & Lin, 2007). Other researchers claim that team effectiveness is better predicted by the team members' social skills and personality characteristics (Baldwin, Bedell, & Johnson, 1997; Ellis et al., 2003). Teams are also more effective if they show efficient decision making strategies and if the team members show commitment toward the team (i.e., the process) and towards the task (i.e., the product) (Williams, Duray, & Venkateshwar, 2006). However, the role of leadership in learning-teams or problem-solving teams is unclear. Some researchers have found negative effects of centralized leadership on performance (Durham, Knight, & Locke, 1997; Johnson, Suriya, Won Yoon, Berrett, & La Fleur, 2002; D. Kayes, 2004) if learning and/or problem solving is the goal, while others report positive effects on team efficiency in teams having appointed a leader or coordinator (Henry & Stevens, 1999; Sivasubramaniam, Murry, Avolio, & Jung, 2002; Strijbos et al., 2004). Team commitment and team effectiveness are also enhanced

when positive interdependence is strong, because the job there can only be done well if team members adequately participate in the process and collaborate (Katz-Navon & Erez, 2005).

In sum, research on the effectiveness of learning-teams includes a variety of variables influencing team performance and team effectiveness, but the number of studies is still limited and results vary. However, research claiming to predict effects on team effectiveness of teams in work settings is often based on laboratory experiments using student teams in educational settings, which poses the question if those teams may represent teams in work settings. Therefore, there is a need to further investigate the characteristics of learning-teams in collaborative learning practices in higher education to establish which variables mediate leaning-team effectiveness in what way.

Research question and methodology

Variations in effectiveness of learning-teams in higher education, as well as insufficient knowledge about variables mediating learning-team effectiveness motivated the start of this research. If a learning-team could be tested and trained on effectiveness before starting or in the start-up phase of a collaborative learning practice, team effectiveness might improve both quantitatively and qualitatively. In order to do this, one must know which factors influence learning-team effectiveness and how these factors are related to each other, which implies that a conceptual framework must be developed and tested, followed by further exploring how these variables mediate the induction of team effectiveness and how this process can be effectively supported in the context of higher education. The main question of this research is: Which variables mediate the effectiveness of learning-teams in collaborative learning practices in higher education in what way and how can the emergence of team effectiveness be facilitated and supported in an early stage of teamwork?

The concept of 'learning-team' in the context of higher education needs explaining. In higher education collaborative learning usually means that the students are given an assignment which must be carried out by collaborating in an ad-hoc team, which has to be completed within a restricted period of time, and which is primarily

aimed at learning through knowledge construction. Also, a learning assignment often implies developing a product or a solution to an ill-defined problem, depending on the knowledge domain the students are being educated for. In higher education, and more specifically in the domain of applied sciences, that while learning-teams focus both on learning and on delivering results, the main objectives are either learning as a team, and/or learning as an individual. In other words, it is the learning that is most important and not the product. In contrast, project teams in work settings will also combine product development with learning as a team, but learning in these settings will be a side-effect and the main focus is product delivery.

This research started with developing and testing a conceptual framework to establish which variables mediate the emergence of learning-team effectiveness and in what way in order to be able to investigate the effects of specific interventions with regard to the variables in follow-up quasi-experiments. However, after developing the conceptual framework on learning-team effectiveness and validating the core aspects of this framework, the first quasi-experiment revealed that contextual factors are also of influence and appeared to be conditional for the emergence of learning-team effectiveness. For instance, if the assignment is not complex and interdependency is not built in, students will tend to divide the overall task into subtasks that can be completed individually without collaborating intensively, so as to reduce the costs of the time-consuming processes of teamwork. Experiencing the impact of the contextual factors resulted in a decision to adapt the overall research strategy by abandoning an experimental design and adopting a strategy of qualitative research to reach a deeper understanding of the evolutionary character of team effectiveness, more specifically how the most important variables mediate the emergence of team effectiveness in an early stage of teamwork. Therefore, after developing and testing the conceptual model on learning-team effectiveness a number of case studies and cross-case analyses were carried out to deepen the insight in the emergence of learning-team effectiveness in the context of collaborative learning in higher education.

Outline of this dissertation This chapter concludes with an overview of the following chapters in this dissertation reporting the steps that were taken in this research. Since these chapters are based on articles that already are published, accepted or submitted, some redundancy in the information in sections dealing with the conceptual framework is inevitable. It means, however, that each chapter can be read independently and reports a complete study.

Chapter 2 | Chapter 2 deals with the conceptual framework for the research. Given the fact that most of the research on team performance and team effectiveness is related to teams in organizational settings, findings of research on team effectiveness in work settings were explored and the relevance of the findings for research on collaborative learning in higher education was discussed. These findings were critically analyzed to determine whether they might be translated to learning-teams in educational settings. The main research question this chapter addresses is: Which variables mediate the effectiveness of student learning-teams in collaborative learning practices in higher education?

Chapter 3 | Chapter 3 deals with testing the importance of the variables mediating learning-team effectiveness. The key variables that are assumed to be important in an early stage of teamwork in collaborative learning practices in higher education have been selected and a plausible model presenting the relations between the key variables was tested. A questionnaire was developed with scales consisting items from validated instruments. Student learning-teams of an Initial Teacher Training program participated in the study. The main research question this chapter addresses is: Which variables mediate the effectiveness of learning-teams in collaborative learning practices in higher education and to what extent do they do this? Based on the main research question three hypotheses were tested and implications were discussed.

Chapter 4 | Chapter 4 reports about four case studies and a cross-case analysis that were carried out in a master program on Learning & Innovation to explore the relations between the key mediating variables and the emergence of team effectiveness in collaborative learning practices in higher education. It offered a predominantly insider perspective since the results of quantitative measurements were tri-

angulated with the results of team interviews. The main research question this chapter addresses is: What is the importance of the key variables mediating learning-team effectiveness in the different stages of teamwork in collaborative learning practices in higher education within the perspective of learning-team development?

Chapter 5 | Chapter 5 also reports about the case studies and cross-case analysis that were carried out in a master program on Learning & Innovation to further explore and explain the importance of the key variables mediating team effectiveness in collaborative learning practices in higher education based on a predominantly outsider perspective. Team communication in team meetings was recorded and analyzed to establish differences between the four learning-teams with respect to their approach toward the task and the team. Findings of the analyzed team communication were triangulated with the results of the team interviews. The main research question this chapter addresses is: In what way do task-related and team-related activities of learning-teams in collaborative learning practices in higher education contribute to the emergence of learning-team effectiveness within the perspective of learning-team development?

Chapter 6 | Chapter 6 reports about two case studies and a cross-case analysis that were carried out in an International Business and Management program to replicate the findings of the previous case studies in a different setting and to explore the perceived effects of tutor interventions on the emergence of learning-team effectiveness. The insider and outsider perspective were combined and results of both quantitative and qualitative measurements were analyzed and triangulated. Tutor interventions were explored by analyzing the recordings of supervised team meetings. The main question this chapter addresses is: What is the importance of the key variables mediating team effectiveness in the different stages of teamwork, how do task-related and team-related activities contribute to learning-team effectiveness, and what are the perceived effects of tutor interventions on team development and the emergence of team effectiveness?

Chapter 7 | Chapter 7 deals with the overall conclusions of the research. The findings of studies that were carried out, the limitations of the research, and some possibilities for future research are being discussed within the perspective of collaborative learning in higher education.

CHAPTER 2

Mediating Team Effectiveness in Collaborative Learning: Developing a Conceptual Framework[1]

1 This chapter is based on: Fransen, J., Weinberger, A., & Kirschner, P. (accepted). Team effectiveness and team development in computer-supported collaborative learning. *Educational Psychologist.*

Collaborative learning requires discussion and argumentation to achieve deep learning and conceptual change. Both the degree and type of argumentation and discussion will be strongly influenced by contextual factors such as task characteristics, team formation, team members' abilities and characteristics, and role assignment within a team. This is also the case for teams in work settings. Building on a critical analysis of the degree to which research on teamwork in organizational settings translates to student learning-teams in educational settings, this chapter discusses the mediating variables of teamwork processes and the dynamics of learning-teams. Based on work-team effectiveness models, it presents a developmental framework with key variables mediating learning-team effectiveness in either face-to-face or online settings.

Introduction

The social-constructivist paradigm holds that collaborative learners should be involved in processes of knowledge construction to achieve deep learning, understanding, and conceptual change through discussion and argumentation (Bereiter, 2002; Bruffee, 1993; Hmelo-Silver, Chernobilsky, & Jordan, 2008). *Learning-teams* are effective to the extent that learners intend to and actually manage to achieve these learning goals. Their goal is to learn while at the same time working on a problem, a project, a task, and so forth. *Work-teams*, on the other hand, are effective when they adequately use their distributed expertise to effectively and efficiently perform as a team to successfully complete a given task. In work-teams, learning may occur as a byproduct of this collaboration. Many employers even see this as an added value of working in teams (A. Kayes, Kayes, & Kolb, 2005; Sessa & London, 2007). The differences between work-team effectiveness and learning-team effectiveness are also mirrored by differences in the focus of research on team effectiveness in both contexts.

Since learning (i.e., knowledge construction) is the primary goal of learning-teams in educational settings, even if the assigned task is to complete a product, team effectiveness is primarily defined in terms of the quality of team learning and individual learning whereas team effectiveness in work-teams is primarily about product quality. This implies that variables mediating learning-team effectiveness can, and maybe even should differ from variables mediating work-team effectiveness, or variables mediating effectiveness in both contexts may differ in their impact. In this chapter the research on work-team effectiveness in organizational settings is critically analyzed to establish to what extent the wealth of work-team research may inform research on learning-team effectiveness. Next, a conceptual framework on learning-team effectiveness for research on collaborative learning is presented.

Research on *work-teams* in organizational settings considers multiple aspects of work-team effectiveness such as speed, performance, accuracy, inventiveness, as well as attitudinal and behavioral indicators within the input-process-output perspective (Bachmann, 2006). Most of this research is related to long-term production teams or task groups in organizations with a focus on task-specific

teamwork, aspects of team leadership, relations between teams and their organizations, and effects of environmental characteristics on team effectiveness (Cohen & Bailey, 1997; Hackman, 1990; Halfhill, Sundstrom, Lahner, Calderone, & Nielsen, 2005; Stewart & Barrick, 2000). Effective teams are defined by these researchers in terms of quality of the outcomes with respect to organizational standards, and satisfaction of team member's needs.

Studies on the effectiveness of *learning-teams* (i.e., research on collaborative learning) in educational settings often focus on aspects quite different from studies on work-teams, and also define team effectiveness in terms of engagement of team members in the learning task (Barron, 2003; Salomon & Globerson, 1989; Wang & Lin, 2007). Furthermore, collaborative learning research focuses on parameters influencing mindful engagement and collaboration such as learning styles and/or cognitive ability (Alfonseca et al., 2006; Webb & Palincsar, 1996), decision-making styles and group interaction (Hirokawa, Cathcart, Samovar, & Henman, 2003), leadership and/or role assignment in learning-teams (Johnson et al., 2002; Strijbos et al., 2004), and the dynamics of specific kinds of learning-teams such as virtual teams (Johnson et al., 2002; Strijbos, Martens, Jochems, & Broers, 2007; Weinberger, Stegmann, & Fischer, 2007). Also, research on collaborative learning not only focuses on parameters influencing collaborative learning outcomes. Recent research has increasingly turned its focus to the processes that take place – both in individual learners as in the team – during collaborative learning (Dillenbourg, Baker, Blaye, & O'Malley, 1996; Dillenbourg & Tchounikine, 2007; Strijbos & Fischer, 2007; Weinberger et al., 2007). This implies a shift from determining the conditions under which students effectively collaborate such as group composition, individual prerequisites and task features (i.e., the conditions paradigm) to determining the interactions that occur, the conditions under which they occur and what the effects of these interactions are (i.e., the interactions paradigm; Dillenbourg et al., 1996). Finally, there has been much research focusing on the learners' cognitive progress during collaborative learning as well as on the socio-emotional processes that occur (e.g., creation and maintenance of social relationships and a sense of community; Kreijns, Kirschner, & Jochems, 2003).

Although it may be assumed that learning-teams in project-based learning or case-based learning encounter similar challenges and constraints in developing teamwork, team cohesion and effective collaboration as ad-hoc project teams in organizations (Chiocchio & Essiembre, 2009), student learning-teams and work-teams typically differ regarding the distribution of expertise within the team (Furst, Blackburn, & Rosen, 1999; Weinberger et al., 2007), and the functional hierarchy and team leadership within the team (Katz, Lazer, Arrow, & Contractor, 2004). This means that while work-teams are often formed with the explicit intention of combining different types of expertise and usually include a designated team leader with accepted team-leader status, learning-teams typically often contain no experts (i.e., they are all learners) or designated leaders with such status in advance. However, both student learning-teams and work-teams must develop as a team to become effective, which means that the relevance and impact of variables mediating team effectiveness should be discussed within the perspective of group development. It is potentially fruitful to explore the variables mediating team effectiveness in both organizational and educational settings to establish prospective similarities and differences on the effects of these variables in both contexts. Therefore, the extent to which research on team effectiveness in work settings and/or computer-supported collaborative work (CSCW) can contribute to the understanding of the research in educational settings and/or computer-supported collaborative learning (CSCL) must be critically analyzed to develop a conceptual framework on team effectiveness and team development in practices of collaborative learning. To this end, a model of group development is presented first to be applied in the context of collaborative learning. Then, research findings from work settings will be reviewed and contrasted with findings from learning settings. Finally, a learning-team effectiveness framework will be discussed including those variables mediating team effectiveness in collaborative learning settings within the perspective of learning-team development.

Models of group and team development

Teams, and especially ad-hoc learning-teams, are often initially ineffective because team members lack necessary information about each other's competences and do not exhibit mutual trust, having not experienced each other's behavior in a team situation (Lewicki & Bunker, 1996). This can be complicated by the fact that students often are randomly assigned to learning-teams or students are re-assigned to a different learning-team during a course or a semester, which result in groups with some students sharing collaboration experiences from previous tasks and others collaborating for the first time (Janssen, Erkens, Kirschner, & Kanselaar, 2009). Such ad-hoc groups experience development – often described as different developmental stages – in which the influence of different variables mediating team effectiveness may vary. For instance, groups with high group-member familiarity (i.e., group members share collaboration experiences from previous tasks and/or because they are friends) develop more critical and exploratory group norms, which leads to more efficient communication and spending less time in monitoring task-related activities (Janssen et al., 2009), which results in the group proceeding through the developmental stages more quickly and/or in a manner different from groups with low group-member familiarity (i.e., so-called zero-history groups). These stages have been described in different models of group development that can be applied in the context of collaborative learning.

Group development models – originally developed to explain group development in organizational settings – can be divided into three categories: linear progressive models, cyclical models, and non-sequential models (Mennecke, Hoffer, & Wynee, 1992). Since these models were not developed to explain group development in educational settings, their use there must be critically examined. *Linear progressive models* suggest that groups progressively develop in a specific direction, maturing over time. Such models imply a set of stages in a more or less strict order. The Tuckman and Jensen model (1977) is the best known example of a linear progressive model. This widely used model for small group development distinguishes five stages of group development, namely: *forming* (i.e., getting to know one another and the task at hand), *storming*

(i.e., establishing positions on the task and roles within the group), *norming* (i.e., reaching consensus about group norms, goals, and strategies), *performing* (i.e., reaching conclusions and delivering results), and *adjourning* (i.e., dismantling the group; reevaluation of team goals with respect to personal goals). Though groups may differ in many aspects and stages are not always linear nor visited only once, the Tuckman and Jensen model has been successfully tested for decades in different contexts. Since students usually are assigned randomly to ad-hoc learning-teams and members need to get to know each other, it is likely that the developmental process will be progressive to some extent though, depending on the length of the task, sometimes not achieving all stages.

Cyclical models also claim that groups develop by proceeding through stages, but hold that groups continually revisit stages during the developmental process. They have to deal with similar issues and problems at different moments as a result of environmental changes, changes within the group, or changes in the task at hand. Progression in cyclical models means that a group matures during smaller or shorter developmental cycles, and that it will flexibly modify its approach to dealing with the same issues over time based upon its prior experiences. A specific ordering of developmental stages is not necessary, although groups will eventually find a workable solution for achieving its objectives, after which it has to be determined if the group continues or disbands (G. Smith, 2001). Cyclical models acknowledge the fact that groups have to be flexible in order to deal with environmental demands and constraints and these models appear to be more capable of explaining group development in the real world by addressing a group's ability to assess new information and adjust their teamwork strategy (G. Smith, 2001). Cyclical models may only be partly applicable in some, long-term educational contexts, because for many short-term learning-teams changes in the environment and changes in the task are less likely to happen. Additionally, whereas cyclical models of CSCW apply to teams that work together over multiple tasks, in CSCL team-composition is typically ad-hoc and changes after task completion, assignments are hardly ever repeated but typically adjusted to advancing levels of competence, and students are usually assigned to

a new team for each new assignment. This, however, does not mean that past experiences with teamwork in ad-hoc learning groups does not influence a student's expectations of teamwork. Research has shown that students entering a new team are affected by their prior experiences in teams with either similar or different backgrounds which affects the developmental pattern of the team (Hinsz, 1995; Rentsch, Heffner, & Duffy, 1994). Although team composition may change with a new assignment, students probably collaborated with other classmates in different team formations, resulting in teamwork mental models becoming stable and groups visiting developmental stages less often or more quickly proceeding through specific stages.

In *non-sequential* models, patterns of development are largely the result of environmental factors such as time constraints and task characteristics. Given the task at hand and the existence of deadlines for delivering results, solving these task-related problems will be of more influence on group development than the dynamics of interpersonal relations (Gersick, 1988). In Gersick's *punctuated equilibrium model* group development is not slow and progressive, but rapid and abrupt. For example, groups working on a task with a clear deadline need time to explore the task before starting to produce results. More or less half way to the deadline, they experience a turning point. Groups that did not perform well will now start performing in order to deliver results on time. Groups that did perform well (i.e., already producing required results) tend to change this performance towards more practical and goal-oriented performance. Deadlines and the task at hand will be of influence on group development and the relations between members will change after passing through the equilibrium point. Given the fact that students tend to act pragmatically (Mao & Zakrajsek, 1993) and to balance the investment of time and effort between teamwork and other activities, the non-sequential models seem to be applicable to some extent and acknowledge the behavior of short-term learning-teams (Bradley, White, & Mennecke, 2003), especially the punctuated equilibrium model (Gersick, 1988). However, research also showed that the more effectively a team operates, the more likely this team follows a linear progressive development (Johnson et al., 2002). Although an

ad-hoc student learning-team probably follows a progressive developmental path since it usually is a mixed group with students having already worked together on previous tasks and students working together for the first time, students still tend to operate pragmatically and economically invest the available time, which implies the importance they place on solving task-related problems and delivering results on time (Chinn, O'donnell, & Jinks, 2000).

The *Team Evolution And Maturation* model or TEAM model (Morgan, Salas, & Glickman, 2001) combines existing group-development theories and ideas on team development into a general team-development model, including Tuckman's stages model and Gersick's punctuated equilibrium model (See Figure 1).

The TEAM model describes a set of developmental stages, but a team does not have to proceed through all stages and may start at different stages, according to past experiences of the team and its members. The model also determines a task-oriented path and a team-oriented path along which teams develop, respectively addressing task-skills like reaching agreement on goals and strategies and delivering results, and team-skills like developing group cohesion on the basis of role division and interdependence. The optimum level of performance is reached when the two paths converge (Figure 1).

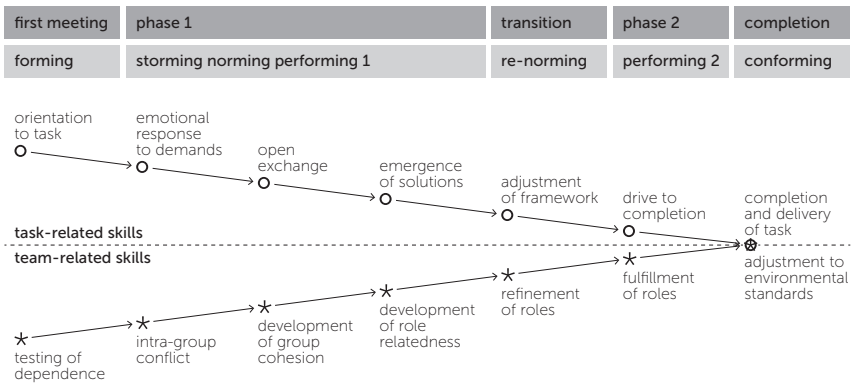

Figure 1

Essentials of the TEAM model with teamwork phases, team development stages, and convergence of task-related skills and team-related skills during team maturation (adapted from Morgan et al., 2001, *Journal of General Psychology*, 120(3), p.281).

The TEAM model seems appropriate for application in the educational context because it acknowledges that ad-hoc learning-teams have to develop by proceeding through stages, while it also acknowledges the importance

of the effect of deadlines on learning-team development, the emergence of a transition phase (i.e., the re-norming stage), and the impact of past experiences with teamwork on the pattern of team development. The TEAM model offers a framework for discussing the variables mediating learning-team effectiveness, assuming that the impact of these variables may differ according to the stage of learning-team development and may have a specific impact on learning-team evolution and maturation. The variables mediating learning-team effectiveness will be explored in the next section, initiated by exploring a framework based on the findings of a review of research on work-team effectiveness.

Variables mediating team effectiveness

The best known framework for teamwork-The Big Five in Teamwork – is based on a meta-analysis of research on team effectiveness in organizational settings (Salas, Sims, & Burke, 2005). It covers five key factors influencing team effectiveness and three supporting and coordinating mechanisms. The Big Five factors are *team orientation*, *team leadership*, *mutual performance monitoring*, *back-up behavior* and *adaptability*. The three supporting and coordinating mechanisms are *shared mental models*, *mutual trust*, and *closed-loop communication*. These variables (i.e., factors and mechanisms) mediating team effectiveness and their importance for the educational setting will be explored, starting with the supporting and coordinating mechanisms as conditional for influencing the Big Five, followed by an exploration of the Big Five. In spite of the popularity and dissemination of the Big Five, the importance of these variables mediating team effectiveness for educational settings has not yet been systematically investigated. The aim is to develop a coherent model of the variables that mediate learning-team effectiveness within the perspective of learning-team development by integrating these findings. It is emphasized, however, that the broad scope of research on team effectiveness and the complexity of the constructs involved inevitably required that some of the more nuanced findings could not be incorporated within each of the following sections and only a selection of the findings for each of the topics that were addressed are reported.

Shared mental models | Developing a *shared understanding* in a team (i.e., compatible mental models of the task that are sufficiently aligned so as to coordinate multiple task-related perspectives and efforts; Derry, DuRussel, & O'Donnell, 1998) is conditional for setting team goals, deciding on strategies, allocating subtasks to team members, monitoring team processes adequately, and communicating effectively (Klimoski & Mohammed, 1994; Van den Bossche, 2006). Team members develop these compatible mental models in a process of negotiating and interrelating each-others' diverse views (Akkerman et al., 2007). Different researchers use different terms with respect to shared understanding such as *common ground* (Beers, Boshuizen, Kirschner, & Gijselaers, 2006), *synergistic knowledge* (Mu & Gnyawali, 2003), *team mental models* (Mohammed & Dumville, 2001), or *shared mental models* (Salas et al., 2005; Stout, Cannon-Bowers, Salas, & Milanovich, 1999). A distinction can be made between mental models that are team-related and those that are task-related (Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000). In *team-related mental models*, the focus is on awareness of team functioning and expected behaviors of the team as a whole and the team members individually. The focus in *task-related mental models* is on information on the materials and strategies needed to successfully carry out the team task.

Each team member's mental model should be sufficiently similar to those of other team members to guide the team as a whole towards the team's objectives, but these need not and should not be exactly the same since input from different perspectives has been found to improve team decision quality and performance (Kellermanns, Floyd, Pearson, & Spencer, 2008). Also, teams have been found to benefit from sharing *transactive knowledge* (i.e., knowledge about other team members' knowledge; Cannon-Bowers, Salas, & Converse, 1993). Recent work-team research has found the accuracy of the shared mental models (i.e., similarity of team members' mental models with a canonical or expert model) to be a more beneficial influence on teamwork processes and team performance than a similarity of team members' mental models (Smith-Jentsch, Cannon-Bowers, Tannenbaum, & Salas, 2008), since team members may develop highly similar mental models which prove to be ineffective to structure the planning and monitoring of

teamwork. With regard to team performance and effectiveness, teams guide their actions based on a shared mental model developed through exchanging different perspectives and team members becoming aware of mental model dissimilarity, but their effectiveness will only increase if there is a convergence within the team towards an accurate shared mental model of teamwork (Smith-Jentsch et al., 2008). In the process of developing (i.e., working) as a team, team members continuously update their shared mental models. Findings suggest that teams engaged in high-quality planning in early stages of teamwork form better shared mental models of each other's information needs during teamwork and perform better (Stout et al., 1999), and team members becoming aware of each other's expertise results in improvement of team performance (Yoo & Kanawattanachai, 1993).

Impact of shared mental models research on collaborative learning research: Collaborative learning, defined as a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem (Roschelle, 1992; Roschelle & Teasly, 1995) implies a situation that can be characterized as 'collaborative' where learners have similar status and similar levels of knowledge (Dillenbourg, 1999), although status differences may exist but these will be less and less official. Learning-teams, like work-teams, have to develop team-related and task-related mental models in early stages of collaboration to become productive and deliver results, although learning-teams tend to focus on task-related mental models as a result of acting pragmatically and being efficient as ad-hoc short-term teams, as well as the need for completing assignments on time (M. Hsu, Chen, Chiu, & Ju, 2007). Student learning-teams, however, differ from work-teams with respect to the ability to develop an elaborate mental model of the final outcomes of collaboration due to the fact that students are, by definition, not experts and mental model dissimilarity between members of learning-teams is likely to be small, as a meta-analysis exploring the correlations between team ability, team heterogeneity and team performance in different team types showed (Chiocchio & Essiembre, 2009). How learners jointly perform and attain their goals may depend on how much time and effort learning-teams

invest at different stages of teamwork in developing shared mental models of the task, goals and strategies, as well as the knowledge and skills of the other team members. These shared mental models will typically develop to some degree in the process of learners working together. At the same time, task-related shared mental models have been regarded as intended outcomes of collaborative learning (Weinberger et al., 2007). CSCL research has built on work-team research to analyze collaborative learning at group level, focusing not only on the individual learning outcomes, but also on the extent to which learners converge towards shared knowledge (Weinberger et al., 2007). This work stresses how learning-teams may particularly benefit from initial knowledge divergence, so that they use each other as complementary learning resources and challenge their own ideas. Ultimately, learners may then converge on a larger body of knowledge that they have shared during collaboration.

Mutual trust | *Mutual trust* implies the shared perception that every individual in the team will perform particular actions important to its members and will protect the rights and interests of all team members (Salas et al., 2005). Without sufficient mutual trust, team members spend too much time and energy protecting, checking, and inspecting each other and each other's' behaviors, and too little time constructively collaborating (Peterson & Behfar, 2003).

Research has shown that trust is a multidimensional construct, differentiable from concepts such as *cognition-based trust* versus *affect-based trust* (i.e., based on knowledge about team members vs. emotional bonds with others; McAllister, 1995), or *trustworthiness* and *trusting behavior* (i.e., expecting others to be trustworthy vs. perceiving trustworthiness as a result of actions of others (Tanis & Postmes, 2005). Research also showed the interrelatedness of trust and friendship, and the effects of an integration of both types (Lewicki & Bunker, 1996; Newell & Swan, 2000). Friendship, which refers to what is labeled as *companion-based trust* (i.e., affect-based trust), is more resilient and based on emotional bonds, as opposed to *competence-based trust* (i.e., cognition-based trust) which is fragile and based on the perception of ability of others to perform as agreed. Furthermore, the development of trust seems to proceed through stages building upon each other starting

with *calculus-based trust* (i.e., trust based on the expected competences of other team members), followed by the emergence of *knowledge-based trust* (i.e., trust based on perceived expertise of other team members), and finally in *identification-based trust* (i.e., trust based on valuing other team members regarding their expertise, their behavior, and as a person; (Lewicki & Bunker, 1996; Sheppard & Sherman, 1998).

One might assume that virtual teams experience more difficulties in developing mutual trust as a consequence of computer-mediated communication,, implying the absence of proximity and therefore of the presence of others, face-to-face communication, shared social settings, and frequency of spontaneous communication (Kiesler & Cummings, 2002). However, research findings show that virtual teams can develop the same levels of trust as face-to-face teams, but that it takes more time to realize this (Jarvenpaa & Leidner, 1999). Virtual teams appear to develop *cognition-based* trust more quickly than face-to-face teams (J. Wilson, Strauss, & McEvily, 2006), and the presence of *swift* trust (i.e., based on information of team members' backgrounds) in an early stage of teamwork is a predictor of high performance of virtual teams (Kanawattanachai & Yoo, 2002). Additionally, team member dissimilarity in age, gender, grade or culture is negatively related to trust development in face-to-face teams, but not in virtual teams due to a reduction in the salience of dissimilarity (Krebs, Hobman, & Bordia, 2006).

Impact of mutual trust research on collaborative learning research: Research on the importance of trust in learning-teams is sparse and on the effects of trust is limited, which may be due to the fact that ad-hoc and short-lived learning-teams have mostly been investigated (Bradley et al., 2003). However, since learning-teams usually have no influence on environmental factors mediating their performance, learning-team members depend strongly on each other to work on the task (Chiocchio & Essiembre, 2009). This underlines the importance of establishing minimal levels of cognition-based trust in early stages of teamwork, and that task cohesion (i.e., agreement on the goals and strategies) may be more important than social cohesion in ad-hoc learning-teams (Boekaerts, de Koning, & Vedder,

2006). Although the focus in learning-teams lies in achieving cognition-based trust (i.e., based on perceived ability of others), companion-based trust (i.e., based on emotional bonds) may interfere with that if students develop friendships as a result of being classmates for some time. This companion-based trust may strengthen mutual trust in a learning-team, but it can also lead to fault-lines within the team as a result of someone taking over a team member's subtask for reasons of a more personal character and not related to team goals (Molleman, 2005). It emphasizes the fact that learning-teams are social systems, with social cognitions both affecting social interactions and resulting from it which may lead to debilitating effects (Salomon & Globerson, 1989), and the emergence of, for instance, the 'free-rider' effect which refers to a team member not investing the required effort assuming that other team members will do (Kerr & Bruun, 1983) and/or status differences within the team when the perceived high ability of one member leads to this member dominating the group activities and receiving more help (Dembo & McAuliffe, 1987).

Closed-loop communication | Communication facilitates teams in updating their shared mental models and engaging in activities regarding task execution, monitoring the process, and adapting to changing conditions (Salas et al., 2005). This increases in importance when the environment increases in complexity, for instance in operating room teams (K. Wilson, Burke, Priest, & Salas, 2005), and implies communication that is closed-loop in character. *Closed loop communication* consists of a team's ability to exchange clear concise information, acknowledge the receipt of that information, and confirm its correct understanding (P. Kirschner, Beers, Boshuizen, & Gijselaers, 2008), as opposed to open-loop communication where the receipt of information is not acknowledged and the correct understanding is also not confirmed (Gillard & Johansen, 2004). Team communication can be characterized as either centralized (i.e., the extent to which one member serves as a hub of communication) or decentralized (Katz et al., 2004). Centralized communication is adequate when the task is simple, but when the task is complex, teams benefit from all team members participating in decentralized communication (Leavitt, 1951; Shaw, 1954).

Impact of closed-loop communication research on collaborative learning research: Research in CSCL reveals that the communication of social and cognitive information is conditional for effective team learning (Van den Bossche, Gijselaars, Segers, & Kirschner, 2006), to allow team members to establish a shared purpose through knowledge of each other's competences and create ownership of the task (Tolmie & Boyle, 2000), to create a sense of community which is conditional for effective collaborative learning (Cho, Gay, Davidson, & Ingraffea, 2007; Wegerif, 1998), and to develop an accurate shared understanding of differences in prior knowledge within the team (Sangin et al., 2011). In CSCL research, different qualities of communication pertinent to learning have been identified such as argumentative quality of learners' utterances (Weinberger & Fischer, 2006). There are indications that collaborative learners acquire better knowledge the more they relate to what their learning partners are saying in what has been termed *transactive talk* (i.e., operating on the reasoning of another; Teasley, 1997). An extra problem for CSCL is that CSCL teams typically have to rely exclusively on computer-mediated communication (CMC) to exchange information within the team. Such environments often lack the tools to allow for effective closed-loop or transactive communication and/or the tools that are available (e.g., chat, discussion boards), due to their often linear and temporal character, do not adequately allow for the reflection needed to achieve effective communication (Lea, Rogers, & Postmes, 2002). One way to facilitate the quality of learners' interactions and especially transactive talk in CSCL is to integrate socio-cognitive structures into a CSCL environment via collaboration scripts (Fischer, Kollar, Mandl, & Haake, 2007; Weinberger, 2011). Such scripts specify, sequence, and distribute roles and activities across a group of learners and thus, guide them to engage in transactive interactions. Weinberger, Ertl, Fischer, and Mandl (2005) found that in a text-based as well as a video-based CSCL environment, learners' interaction could be scripted towards becoming more transactive and that the group members acquired more knowledge individually by distributing and rotating the roles of analyst and critic in groups of three and by prompting learners to peer review activities and ask critical questions about their partners' contribu-

tion to the task. Even if learners do not follow a script perfectly, they can increase the probability of transactive interactions and closed-loop communication by asking learners to explicate how they have understood their partners' contributions.

Team orientation | *Team orientation* implies both a preference for working with others as well as a tendency to enhance individual performance through coordination of one's actions with other team members while performing group tasks (Salas et al., 2005). Team orientation facilitates decision making, and cooperation and coordination among team members, which in turn results in increased team performance (Eby & Dobbins, 1997). Team orientation is attitudinal and a result of team members' individual attitudes towards teamwork, and therefore depends on a team's composition. In work settings, this attitude and its development can be influenced by factors such as the chosen reward structure (e.g., rewarding the team as a whole for a good product vs. rewarding only the team leader), team composition (e.g., team size and team characteristics matching task demands), and single-team identity (e.g., belonging to only one long-term team with mostly permanent members; Campion, Papper, & Medsker, 1996).

Impact of team orientation research on collaborative learning research: Learning-teams differ from work-teams in the sense that team members are supposed to learn together, that assessment is often individual, which may inhibit learning (Underwood, 2003), and students tend to do what the teacher asks for. Nevertheless, in educational contexts team orientation can be influenced to some extent by the teachers through team formation procedures (e.g., random vs. planned for specific pedagogical reasons), choice of assignments (e.g., open and divergent vs. closed and convergent) and reward system (e.g., assessment of individuals vs. assessment of the group vs. both). Team formation based on learner characteristics such as learning strategies have been shown to be ineffective, while forming heterogeneous ability groups have been shown to affect team orientation where low-ability students and high-ability students perform equally well (Webb & Palincsar, 1996). With respect to choice of assignments, team orientation and learning have been affected most when authentic, complex and challenging assignments requiring

collaboration are used (Blumenfeld et al., 1991; F. Kirschner, Paas, & Kirschner, 2009a, 2009b, 2011b). The effects of reward systems and assessment strategies on peer learning vary according to the choice of assessment in a given situation, but assessment only positively influences team orientation if assessment of the task and process are balanced, is focused on both the individual and the group, and if students are co-responsible through peer-assessment and self-assessment (Boud, Cohen, & Sampson, 1999; Willcoxson, 2010). While this is the case, team orientation has often been regarded as a learner trait (Driskell, Goodwin, Salas, & O'Shea, 2006). Learners have been found to develop a resistance to working in teams due to multiple negative experiences in past collaborative learning experiences such as increased time and work investment (i.e., increased transaction costs), having to support and/or tolerate 'social loafers' and 'free loaders', and a lower return on their time and work investment (Hillyard, Gillespie, & Littig, 2010). The 'lone wolf' phenomenon, referring to a learner's preference to work alone (Feldman Barr, Dixon, & Gassenheimer, 2005), or silent participation (Remedios, Clarke, & Hawthorne, 2008) may pose a greater problem in CSCL teams – as opposed to face-to-face teams – due to the absence of non-verbal information mediated by being physical present in team meetings to explain a team member's behavior (Kerr & Bruun, 1983; Kiesler, Siegel, & McGuire, 1984; Lea, Spears, & De Groot, 2001). In contrast, team orientation may be stimulated through positive experiences with collaborative learning (e.g., feelings of increased group efficacy; F. Kirschner, Paas, & P. Kirschner, 2011a). Also, the teacher can positively influence orientation by offering a clear purpose and written instructions, by matching team size to the pedagogical objectives, by maximizing team longevity, by giving students a say in team assignments, by highlighting the value of each members' contributions, by implementing specific forms of peer-assessment such as peer-rating, and by actively supporting team development and the process of teamwork (Bacon, Stewart, & Silver, 1999; Felder & Brent, 2001).

Team leadership | Effects of *team leadership* on team effectiveness have been widely studied in different settings and contexts (Cummings & Cross, 2003; Ferrante, Green, & Forster, 2006; Hackman, 1990; Nembhard & Edmondson, 2006).

The effect of team leadership also depends on the type of team and task at hand, which means, for example, that long-term teams consisting of members with specific expertise to execute subtasks within the overall task have been found to benefit from *directive leadership*, especially if a task implies execution of specific subtasks in a strict order and/or addresses critical or life-threatening situations (Hannah, Uhl-Bien, Avolio, & Cavarretta, 2009). In contrast, a short-term team facing problems that require new creative solutions will benefit most from *transformational leadership*, aimed at encouraging member autonomy and empowerment (Alimo-Metcalfe & Alban-Metcalfe, 2001). A meta-analysis of research on the relationship between team member satisfaction and leadership style showed that teams prefer *democratic leadership* instead of *autocratic leadership*, although the effect on member satisfaction is moderated by team size, and team composition (Foels, Driskell, Mullen, & Salas, 2000).

This characterization of types of leadership resembles the distinction made between *centralized leadership* (i.e., one acknowledged leader) and *distributed leadership* (i.e., every team member is both a leader and a follower; (Mehra, Smith, Dixon, & Robertson, 2006). Research showed the importance of *emergent leadership* (i.e., leadership which changes and emerges based upon the need for the reinforcement, creation and ongoing evolution of team structures that guide the actions of team members), especially in effective technology-supported self-organizing groups (Heckman, Crowston, & Misiolek, 2007). This emergent leadership refers to a shift in leadership from distributed first-order leadership in early stages of teamwork to a specific type of centralized second-order leadership in later stages. First-order leadership focuses on reinforcing existing structures through task coordination, substantive task contribution, group maintenance, and boundary spanning while second-order leadership aims at modifying existing structures by influencing team member behavior to improve task execution, reinforce cohesion, and deal with environmental demands. This second-order leadership is action embedded, which means that a team member only gets the permission to lead after contributing substantively to the team. First-order distributed leadership is conditional for

the acceptance of second-order centralized leadership, since (1) team members have to agree on such centralization, (2) the emergent second-order leader must already have performed and demonstrated first-order leadership behavior, and (3) a team must have developed accurate task-related and team-related mental models (Heckman et al., 2007).

Impact of team leadership research on collaborative learning research: Learning-teams, and especially virtual learning-teams, tend to benefit from shared leadership for effective learning (Johnson et al., 2002), provided that inequality in participation levels does not get locked-in early in the process of teamwork as a result of dominant members' proposals or contributions (Kapur, Voiklis, & Kinzer, 2008). Teams relying too much on directive leadership tend to learn less through limited discussion (Durham et al., 1997). Also, learning-teams usually have a short lifecycle and are often supposed to foster equal participation, which implies that team leadership may be less influential for a learning-team's effectiveness, except when critical moments appear (e.g., in the case of fast-approaching deadlines for submission of products). Hogg, Abrams, Otten, and Hinkle (2004), for example, found that in a critical situation, a team evaluates its performance to that point in time and then adapt its strategies to deliver a timely result. This adaptation includes redistribution of subtasks and roles, often resulting in the emergence of a type of centralized leadership where the most prototypical member becomes the team leader because (s)he is seen as the personification the ideal team player (Hogg, Abrams, Otten, & Hinkle, 2004). In the sense that collaborative learning in general and CSCL in particular has been regarded as means to foster equal participation in learning processes, leadership in learner groups has mainly been problematized in the few studies on leadership in collaborative learning contexts (Garrison & Cleveland-Innes, 2005; Johnson et al., 2002). However, leadership in collaborative learning, and especially in face-to-face collaborative groups, is difficult to differentiate from helping behavior and should be placed on a continuum of behavior of purely procedural to purely inspirational within the perspective of collaborative reasoning (Miller, Sun, Wu, & Anderson, in press). Leadership may emerge if a team member has the necessary

leadership competence (i.e., problem-solving skills, social judgment skills, knowledge) with leadership being primarily task-oriented and procedural (i.e., transactional leadership) or both task-oriented and relationship-oriented and therefore inspirational (i.e., motivating and beneficial with respect to successfully solving the learning task together) similar to the emergence of second-order leadership in distributed teams (Heckman et al., 2007).

Mutual performance monitoring | *Mutual performance monitoring* implies keeping track of one's fellow team members' work while carrying out one's own work to ensure that all is running as expected and procedures are followed correctly (Salas et al., 2005). The more complex a task (i.e., the greater the number of elements and the higher the degree of interactivity between those elements (P. Kirschner, 2002), the more important mutual performance monitoring will be, and when a task becomes stressful as a consequence of time constraints, mutual performance monitoring is conditional for a team's performance (Porter, Gogus, & Chien-Feng Yu, 2010). Mutual performance monitoring requires a shared understanding of task and team responsibilities (i.e., a shared mental model), otherwise feedback becomes inconsequential and monitoring will be ineffective (J. Hsu, Chang, Klein, & Jiang, 2011; Ying & Erping, 2010). Also important is trust, because only in a trusting climate will members react positively to feedback of others (Peterson & Behfar, 2003).

Impact of mutual performance monitoring research on collaborative learning research: Research in educational contexts is less focused on mutual performance monitoring for keeping track of each-others' work, but more on how mutual performance monitoring influences interaction between learners and the learning process (Dillenbourg et al., 1996; Wecker & Fischer, 2010). Wecker and Fischer (2011) applied and faded a collaboration script in a text-based CSCL environment to facilitate learners' argumentation by prompting learners, for instance, to provide counter-arguments, to warrant and to qualify their claims. To avoid learners falling back to low-quality argumentation after the script has been faded, peers were instructed to continuously monitor each other's argumentative moves. Fading scripts in combination with peer monitoring facilitated levels of self-regulation and

knowledge on how to argue. Although research on role assignment within a team (i.e., by a tutor or the team itself) is still limited, research on assigned or acquired roles has been shown to affect perceived team efficiency by increasing awareness of group interaction and collaboration (Weinberger, 2011). Therefore, role assignment within learning-teams may facilitate and support effective mutual performance monitoring because students in role groups contribute more task-specific and coordination-focused statements (Schellens, Van Keer, De Wever, & Valcke, 2007; Strijbos et al., 2007). Also, balanced teams with respect to role distribution show more efficient and effective interaction than non-balanced teams (Roberts & Nason, 2004).

Back-up behavior | *Back-up behavior* is the ability to anticipate other team members' needs through accurate knowledge of their responsibilities and to shift the workload among members to achieve balance during periods of high workload or pressure, and is therefore related to shared mental models and mutual performance monitoring (Salas et al., 2005). Back-up can be provided through feedback and coaching to improve performance, assisting a teammate in performing a task, or completing a subtask for a team member when work-overload is detected. (Marks, Mathieu, & Zaccaro, 2001). In this sense, back-up behavior directly influences team performance. Back up behavior is distinguished from 'helping' in the sense that back-up behavior is a response to the recognition of a genuine need for assistance (Porter et al., 2010; Porter et al., 2003).

Impact of back-up behavior research on collaborative learning research: Research by Molleman (2005) implies that back-up behavior may sometimes be detrimental for learning-teams. His research has shown that when someone takes over a subtask of a team member for personal reasons not related to the team or task, it can lead to 'fault-lines' within the team, mirroring the diversity structure of a team, and potentially dividing a team into subgroups, especially when conflicts arise and team communication decreases. Back-up behavior as a response to "free-riding" or social loafing may equally impair collaborative learning (Salomon & Globerson, 1989), since contributing to the results is then left to the more motivated members in the team.

Adaptability | *Adaptability* is the ability of a person or a group to adjust strategies through back up behavior and a reallocation of intra-team resources, or by altering a course of action or team repertoire in response to changing internal and external conditions based on information gathered from the environment (Salas et al., 2005). Adapting to new situations requires both the existence of mutual performance monitoring and shared mental models, especially an elaborate mental model of the final outcomes (Chiocchio & Essiembre, 2009).

Impact of adaptability research on collaborative learning research: Although external conditions usually do not change or only change marginally in the context of collaborative learning in educational settings, internal conditions may change which force a learning-team to adapt its goals and/or strategies. To do so, the team must be aware of changing internal conditions; all team members must be informed based on information that is constantly being updated. With respect to CSCL environments, adaptability has been facilitated through the use of awareness features which inform learners about processes and states of the team and its members (P. Kirschner, Strijbos, Kreijns, & Beers, 2004). Tools that facilitate awareness often collect and aggregate information (e.g., on how participation is distributed across a learning-team) and mirror that information back to the learning-team (e.g., Kaplan et al., 2009). Awareness tools may enable learners to analyze their interactions and thus, facilitate them to self-regulate and adapt their behavior. However, in order to adequately decide on adapting goals and/or strategies the team must have developed shared mental models with respect to team goals and distribution of skills and expertise within the team (Zhou & Wang, 2010).

A conceptual framework for team maturation

In the previous section the implications of CSCW research for research on CSCL with respect to the coordinating and supporting mechanisms conditional for updating the five factors influencing team performance have been discussed. In this section the discussion of the implications will be integrated into a framework of team effectiveness in CSCL within the perspective of learning-team development. The conceptual framework presented here is the

combination of the variables elaborated upon and aspects of the TEAM model of group development. The stages of this model provide a frame for positioning the variables mediating team effectiveness, offering insights into which variables are important in which stage to attain team effectiveness. The model expands on existing models of learning-team effectiveness by integrating variables mediating learning-team effectiveness derived from a broad literature survey with a model of team development that can be applied for learning-teams in educational settings. In the framework a distinction is made between coordinating mechanisms and behavioral components (See Figure 2).

Coordinating mechanisms are conditional for updating the behavioral components and for facilitating team development. *Behavioral components* are process characteristics of teams, some of which are directly related to team effectiveness. Closed-loop communication is both a coordinating mechanism and a behavioral component (i.e., actually communicating), since team members have to communicate both effectively and transactively (i.e., build on each other's reasoning and exchange ideas, preferences, information and feedback) to produce the outcomes of communication conditional for effectively monitoring teamwork, deciding on changing strategies and re-allocating subtasks within the team. Mutual performance monitoring is crucial to the team's understanding of a change in task characteristics and/or of problems with the team's workload distribution and the extent to which mutual performance monitoring, back-up behavior and/or adaptability mediate performance. In a best case scenario with a well-composed team and unchanging task characteristics, mutual performance monitoring should result in effective task execution through participation of all team members in a manner that is expected and that was agreed upon. If, based upon mutual performance monitoring, workload distribution problems are signaled, then back-up behavior will mediate performance (i.e., workload distribution problems will be solved through adequate back-up behavior). If, based upon mutual performance monitoring, a change in task characteristics is signaled as a result of environmental changes, then adaptability will mediate performance (i.e., a change in goals and/or strategies might require subtask re-allocation and/

or role re-division within the team). If, based upon mutual performance monitoring, a change in task characteristics is signaled as well as a workload distribution problem due to the adaptation occurs, performance is mediated through adaptability and back-up behavior respectively. *Team effectiveness*, as dependent variable in the framework, includes the quality of the team's performance as well as the perceived satisfaction of individual needs of team members.

Team orientation and team leadership are not considered key variables in the context of learning-teams in collaborative learning practices and are therefore left out of the framework, though both could be important in early stages of learning-team development, because a shortage of team orientation debilitates team performance (Hillyard et al., 2010) and dominant leadership might result in an early lock-in of participation diversity (Kapur et al., 2008). Also, a specific type of centralized leadership aimed at coordinating a team's performance can emerge during the so-called transition phase if re-norming leads to acknowledging the necessity of adapting the team's strategies and the need for coordination of the process (Heckman et al., 2007).

The *developmental perspective* indicates the position of these framework components and by indicating which of these components are important in different stages of teamwork, we are highlighting potential areas for future investigation.

Mutual trust (i.e., the perception that team members perform as agreed and protect each other's interests) is not considered as crucial for the effectiveness of ad-hoc learning-teams, but typically evolves during the process of teamwork, starting with the build-up of calculus-based trust (i.e., trust based on the expected competences of others) in early stages until achieving knowledge-based trust (i.e., trust based on the perceived expertise of others) in later stages. It is not likely that identification-based trust (i.e., trust based on valuing others regarding expertise, behavior, and as a person) will emerge in short-term learning-teams, other than the companion-based trust (i.e., trust based on emotional bonds with others) that already existed as a result of friendships between classmates. The impact of mutual trust on learning-team

effectiveness is considered limited, but minimal levels of cognition-based trust (i.e., trust based on knowledge about others) probably are necessary during both early and later stages of teamwork for building shared mental models, and for smoothly passing through the transition phase and to perform well (Greenberg, Greenberg, & Antonucci, 2007).

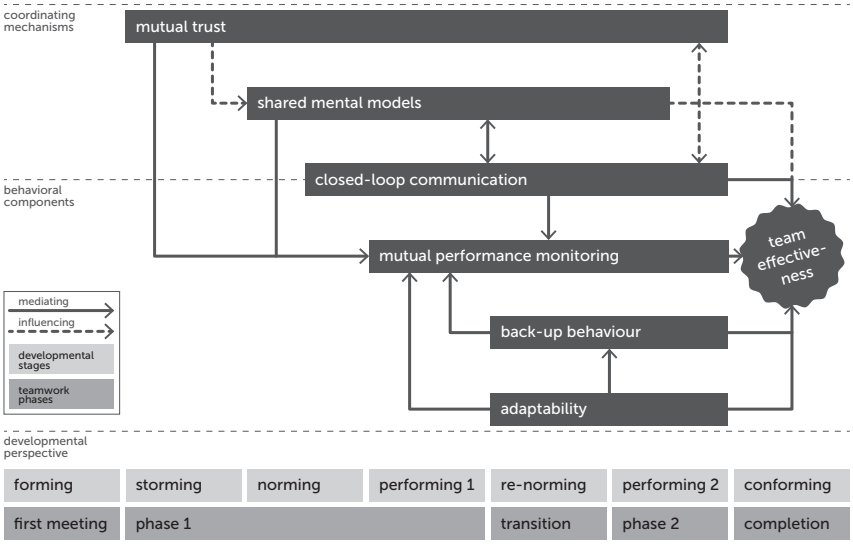

Figure 2

Framework with variables influencing or mediating learning-team effectiveness positioned within the perspective of learning-team development.

Building shared mental models in early stages of teamwork to establish sufficient levels of team and task awareness is important for achieving learning-team performance (Engelmann, Dehler, Bodemer, & Buder, 2009). This is especially the case since student learning-team members usually lack the expertise needed to imagine an elaborate model of final outcomes, and depend on each-other for successfully completing the task since they have limited influence on environmental factors mediating the team's performance (Chiocchio & Essiembre, 2009). Accurate shared mental models influence team effectiveness directly as well the effectiveness of closed-loop communication and mutual performance monitoring.

Mutual performance monitoring, back-up behavior and adaptability are important during the performing stages. Closed-loop communication is important throughout the whole process of team collaboration, but particularly during performing stages in order to monitor the

teamwork effectively. Mutual performance monitoring is crucial during both performing stages as well as the re-norming stage to decide if everything is on track and whether outcomes meet the intended quality. Back-up behavior and adaptability are probably important only during the re-norming stage and the second performing stage when a learning-team has to speed up team performance in order to complete the task and deliver results on time. Team effectiveness will be mediated by back-up behavior when work-load distribution problems arise, mediated by adaptability in cases of changing environmental demands, and mediated by both back-up behavior and adaptability if tasks have to be reallocated within the team as a result of changing goals and/or strategies to meet an approaching deadline.

Conclusions

The purpose of this article was to analyze the relevance of the research on work-team effectiveness in organizational settings for the research on learning-team effectiveness in educational settings. Although the variables mediating the effectiveness of teams in workplace settings are applicable to learning-teams in educational settings, some restrictions are important. Learning-teams can differ fundamentally from work-teams regarding the distribution of power and expertise within the team (e.g., all team members have more or less the same status and contribute more or less the same limited expertise), influence on environment and resources (e.g., learning assignments are fixed, resources are limited and cannot be controlled, and learners cannot imagine elaborate models of outcomes), the purpose of collaborating (e.g., learning is the most important goal, producing results is additional), the necessity of efficiency (e.g., effective learning may be mediated by costly debates and negotiations, and sub-optimal production), and the duration of teamwork (e.g., most learning-teams that have been investigated are short-term teams). These characteristics do have an impact on the exact nature of the variables mediating team effectiveness and on the importance of their influence in the different phases of teamwork. Additionally, development of learning-teams may be specific (e.g., focusing primarily on developing task skills and less on team skills) as a result of a restricted duration of team-

work, and of students acting pragmatically as a result of balancing teamwork with competing personal interests, as well as students perceiving deadlines to be met and grading as most important. Learning-team development can be characterized as linear progressive to some extent, including a transition phase when a deadline approaches. As a result of that, the variables mediating learning-team effectiveness must be discussed within this framework of learning-team development and in the perspective of learning-team characteristics mentioned before.

Based upon the earlier discussion, what may be concluded is:

- Shared mental models are conditional for learning-teams to collaborate effectively, but at the same time they are the objective of collaborative learning. Therefore, shared mental models have to be considered a variable on two levels.
- Collaborating for restricted time periods and student pragmatism and task-orientedness (e.g., getting it finished by date X, and Y is enough for a passing grade) will probably impact the importance of mutual trust in learning-teams.
- In most learning situations there is probably no need for team leadership, only coordination, although role division and inequality of participation are important issues in collaborative learning practices, which could be dealt with by assigning roles and/or scripting collaboration.
- Team orientation is vulnerable due to differing attitudes of students towards collaborative learning as a result of past experiences with teamwork. While difficult to influence, it can be stimulated if students experience less uncertainty through collaborating, if teams are kept small, and if team composition is kept stable.
- Back-up behavior is important, although the extent to which learning-teams will show back-up behavior depends on commitment to the team and to teamwork. Also, backing-up may become helping out for reasons not related to team goals.
- Adaptability is probably less important for student learning-teams with regard to responding at changing environments, since assignments are fixed, and goals and deadlines are set and usually will not change.

- Communication, and more specifically closed-loop communication, is important, though the nature of communication will depend on the type of learning task and task complexity with communication for developing a shared mental model and monitoring the production process in project-based learning and for debate and negotiation in knowledge-construction situations.
- The nature of mutual performance monitoring probably differs according to the characteristics of an assignment with mutual performance monitoring equaling the monitoring of teamwork in workplace settings for project-based learning, but mutual performance monitoring will be distributed in collaborative learning practices aiming at knowledge construction due to the transactive nature of learning.

The conceptual framework is an attempt to integrate theories of group development into a context-specific model for learning-team development and discussing variables mediating learning-team effectiveness within this perspective. It therefore contributes to the need to address issues why groups develop differently, how different aspects of interaction are linked together, and what mechanisms underlie the transition from stability to instability and back again (Arrow, Poole, Henry, Wheelan, & Moreland, 2004). The conceptual framework also builds on the *multiple sequence model* of group development (Poole, 1983), a dynamic contingency model of group development presenting development as a process of continuously evolving tracks of group activities that intertwine over time, more specifically task process activities (i.e., managing the task), relational activities (managing relationships among members), and a topical focus (i.e., issues of concern to the group at given points). If development on these tracks converges in a coherent pattern, phases of group development may also be recognized (Poole, 1983), similar to the convergence of team and task skills in the TEAM model (Morgan et al., 2001) which explains group development of ad-hoc learning-teams probably better. By combining the developmental perspective with the adapted Big Five framework, presenting the variables mediating learning-team effectiveness, relationships between the task activities, the team activities and team development

are becoming more explicit by addressing how aspects of interaction are linked together and what transitions a given learning-team may face and why. Recent studies investigating learning-team development and effectiveness by analyzing team member participation based on the Big Five framework did not offer information on the five components for teams to decide on how to adequately manage teamwork since only visualizations were used presenting team activity linked to aspects of the Big Five without normative information on what learning-teams are supposed to do, assuming that if teams are aware of these interaction patterns they may use this information to improve team performance by taking normative decisions themselves (Kay, Maisonneuve, Yacef, & Reimann, 2006). The conceptual framework presented in this chapter offers additional insight into the relative importance of variables mediating learning-team effectiveness in different stages of learning-team development, although this has to be confirmed in follow-up research. Research on team effectiveness in collaborative learning settings should acknowledge the exact nature of variables mediating team effectiveness and their influence in different stages of learning-team development.

CHAPTER 3

Mediating Team Effectiveness in Collaborative Learning: Testing the Conceptual Framework[2]

2 This chapter is based on: Fransen, J., Kirschner, P., & Erkens, G. (2011). Mediating team effectiveness in the context of collaborative learning: The importance of team and task awareness. *Computers in Human Behavior*, 27, 1103-1113.

Learning-teams in practices of collaborative learning in higher education executing a collaborative assignment are not always effective. To remedy this, there is a need to determine and understand the variables that influence team effectiveness which were selected and discussed in the previous chapter. This chapter aims at determining the key variables of this conceptual framework and testing their importance in mediating team effectiveness of learning-teams in practices of collaborative learning to establish its value for future experiments on influencing team effectiveness. Results of the study confirmed the importance of developing shared mental models, and to some extent mutual performance monitoring for a learning-team to become effective, but also of interpersonal trust as being conditional for building adequate shared mental models. Apart from the importance of team and task awareness it showed that learning-teams in higher education tend to be pragmatic by focusing primarily on task aspects of performance and not team aspects. Further steps have to be taken to validate this conceptual framework on team effectiveness.

Introduction

The use of collaborative learning is often based upon the social-constructivist paradigm that students should become involved in a process of knowledge construction through discussion, debate or argumentation, which will result in deep learning, understanding, and ultimately conceptual change (Bereiter, 2002; Bruffee, 1993; Geelan, 1997; B. Smith, 2002). Within this paradigm, learners working with conceptual artifacts on the basis of an open learning assignment with built-in interdependency is considered conditional for meaningful participation in knowledge construction activities (Blumenfeld et al., 1996). The use of technology for implementing collaborative learning practices is widespread and when student learning-teams partly or exclusively communicate and discuss with each other online (synchronously or asynchronously), collaborative learning is defined as computer-supported collaborative learning (CSCL). Learning-teams that collaborate with the shared intention of achieving deep learning and conceptual change are considered to be effective learning-teams (Salomon & Globerson, 1989). Team effectiveness is not only expressed by the quality of team outcomes, but also includes the quality of the team's performance, as well as the perceived satisfaction of the needs of individual team members (Hackman, 1990), and team effectiveness not only depends on task characteristics and shared intentions, but also by factors, such as team formation, team members' abilities and characteristics, role assignment within a team, decision making strategies of a team, team leadership, and interdependency.

Team formation based on learner characteristics such as their learning strategies has proved either to be ineffective (Tongdeelert, 2003; Webb & Palincsar, 1996), or only partly effective when specific aspects of learning strategies and/or when students collaborate in pairs are considered (Alfonseca et al., 2006; Paredes & Rodriquez, 2006). The fact that learning strategies are defined and operationalized in many different ways complicates the process of grouping learners for collaborative learning practices (Sadler-Smith, 1997). *Cognitive ability* of team members appears to positively affect team learning (Ellis et al., 2003), but learning-teams usually are not composed on the basis of differences in the cognitive ability of the students. The assignment of *functional roles* to team members tends

to increase the effectiveness of learning-teams (Strijbos et al., 2004) for assigned teams, at-random formed teams and student-led formed teams (Wang & Lin, 2007). Team effectiveness can partly be predicted by the team members' *social skills* and *personality characteristics* (Baldwin et al., 1997; Ellis et al., 2003; Halfhill et al., 2005; Morgeson, Reider, & Campion, 2005). Teams are also more effective if team members show *commitment* toward the team (i.e., the process) and towards the task (i.e., the product) (Hirokawa et al., 2003). The role of *leadership* in learning-teams or problem-solving teams is unclear. Some researchers have found negative effects of leadership on team performance if learning and/or problem solving is the goal (Alper, Tjosvold, & Law, 1998; Cummings & Cross, 2003; Durham et al., 1997; Johnson et al., 2002; D. Kayes, 2004) while others report positive effects on team efficiency in teams having appointed a leader or coordinator/planner (Henry & Stevens, 1999; Sivasubramaniam et al., 2002; Strijbos et al., 2004). Finally, team effectiveness was found to be enhanced when *positive interdependence* is strong (Gully, Incalcaterra, Joshi, & Beaubien, 2002; Katz-Navon & Erez, 2005; Shea & Guzzo, 1987).

Although learning-team effectiveness is influenced by many of these factors in both contiguous (i.e., face-to-face) collaborative learning as well as in CSCL, effects vary greatly according to contextual characteristics of a learning practice. There is a need for insight in the underlying factors that influence team effectiveness and how these factors are related to each other; regardless of the context of the learning practices. Establishing what these factors are offers opportunities to train learning-teams on effectiveness before starting or during the start-up phase of a learning practice. As a result, effectiveness might improve both quantitatively and qualitatively. Existing frameworks on team effectiveness developed in the context of work-teams in organizations are not fully applicable for learning-teams. A conceptual framework for learning-teams collaborating in either a face-to-face or online way, based on those work-team effectiveness models, has been developed and in this chapter the factors influencing team effectiveness will be explored further in order to select key factors and test their relative importance in mediating team effectiveness in collaborative learning practices.

The conceptual framework

There is much research on teamwork and team effectiveness, though mostly related to production teams or task groups in organizations (Hackman, 1990; Halfhill et al., 2005; Shea & Guzzo, 1987; Stewart & Barrick, 2000). A problem here is that this research focuses on long-term teamwork, task-specific team-work, aspects of leadership within teamwork, relations between work-teams and the organizations in which they are embedded, and the effects of characteristics of work environments on team effectiveness. Aspects which are often not fully relevant in learning-teams, as was already explored and discussed in the previous chapter. Studies on effectiveness of learning-teams often focus on one or more of these aspects and their possible effects on learning-team performance, and team effectiveness is often defined differently (Barron, 2003; Fleming & Monda-Amaya, 2001; Henry & Stevens, 1999; Rulke & Galaskiewics, 2000; Salomon & Globerson, 1989). The definitions of effective learning-teams by these researchers range from 'establishing a joint problem-space as a team' to 'goal attainment with respect to the quality standards of the organization and satisfaction of team member's needs'. In other words, there appears to be no shared framework on what learning-team effectiveness is.

Another problem is that in most work-team-effectiveness models, the teamwork itself is not specified, but only those factors that might promote effective teamwork or detract from it are explored (Brannick, Salas, & Prince, 1997; Gully et al., 2002). Furthermore, some researchers explore the dynamics of a specific kind of learning-teams, for instance virtual learning-teams, which makes it difficult to generalize the findings to learning-teams operating in a face-to-face or in a blended context (Martins, Gilson, & Maynard, 2004; Warkentin & Beranek, 1999; Yoon, 2006).

Complicating the situation further is the fact that research on the influences on learning-team effectiveness is not always aimed at variables that can be controlled, but also on conditions or team inputs that cannot (Martins et al., 2004). Conditions or team inputs are for instance: team composition, member characteristics, team size, diversity within the team, team potency, team efficacy, time constraints, and task characteristics. Those conditions are either fixed or can only partly be influenced as a result of institu-

tional regulations and/or the type of students enrolled in a given program. This chapter focuses on controllable variables influencing team effectiveness in the process of team collaboration. These variables will be briefly explored in the next section.

Variables mediating team effectiveness

Salas et al. (2005) developed a framework presenting the most important variables influencing teamwork. They called it 'The Big Five in teamwork', introducing five key factors influencing team effectiveness as well as three mechanisms that support and coordinate this. The five key factors are team leadership, team orientation, mutual performance monitoring, back-up behavior and adaptability. The supporting and coordinating mechanisms are shared mental models, mutual trust, and closed-loop communication. All variables and mechanisms are important for a work-team to be successful, and probably actually develop during the time-span that a team executes a task, instead of 'being there' when a team starts. It was stated that the Big Five are important only if the task a work-team has to carry out requires the commitment and participation of all team members, which means that team members must be highly interdependent (Wageman, 1995). In a true collaborative task, interdependence is implicit, as the task can only be completed successfully if team members can and must depend on each other. In this section the five key factors and the three supporting and coordinating mechanisms will be explored within the perspective of their significance for learning-teams in higher education.

Effects of *team leadership* on team effectiveness are widely studied in the research on teamwork in different settings and contexts, but the importance of *leadership* in learning-teams is questionable (Johnson et al., 2002; D. Kayes, 2004). Effective learning in learning-teams, especially in virtual learning-teams, tends to benefit more from shared leadership than individual leadership. Learning-teams relying too much on directive leadership tend to learn less because strong leadership leads to limited discussion. The effect of team leadership may also depend on the type of team and task at hand. Long-term work-teams consisting of members with specific expertise to execute subtasks within the overall task obviously need

directive leadership, especially if the task implies execution of specific subtasks in a strict order and/or addresses critical or life-threatening situations. This specific type of leadership might be defined as directive, and in cases of crisis teams or critical teams as 'commander-type' of leadership. In contrast, learning-teams usually have a short lifecycle and can be characterized as democratic as a consequence of the expertise being distributed more equally within a team. Leadership in learning-teams, if at all needed, will likely be of the coordinator-type, implying someone supervising the team and task process. All team members are expected to participate equally in the process of knowledge construction through discourse and negotiation, so that leadership in terms of combining and synchronizing individual contributions, and ensuring that members understand their interdependence, is not crucial. Leadership will probably evolve as collective leadership, resulting in a learning-team appointing some sort of coordinator, independent of whether it is face-to-face teamwork and collaborative learning (Sivasubramaniam et al., 2002) or within the context of CSCL (Johnson et al., 2002). It is therefore hypothesized that team leadership is not critical for the effectiveness of learning-teams, except when critical moments appear (e.g., in the case of fast-approaching deadlines).

Team orientation is attitudinal in nature. It implies both a preference for working with others as well as a tendency to enhance individual performance through coordination and evaluation, and the utilization of task inputs from other members while performing group tasks. Teams could be characterized to the extent that the team members value teamwork as enriching and necessary for the development of solutions to complex problems (Kasl, Marsick, & Dechant, 1997). Related terms are *collective orientation*, but this is usually focused on culture instead of context and implies the preference for accomplishing group goals rather than individual goals (Wagner, 1995), and *team cohesion*, which refers to the desire to work with a particular team, rather than to work in team settings. Team orientation is said to facilitate team performance through better decision making, resulting in increased cooperation and coordination among the team members (Eby & Dobbins, 1997). As a result, team performance is facilitated through increased

task involvement, information sharing, strategizing, and goal setting. The fact that team orientation is attitudinal makes it more difficult to influence and it probably is a result of team members' individual attitudes towards teamwork, and therefore depends on the team's composition. It is a condition that is difficult to control in the educational context, since students usually have no say in team formation and/or choice of assignments, and is therefore not a variable that could/should be influenced.

Communication is relevant in all stages of teamwork, not in the least for providing feedback on individual performance and task execution to regulate the teamwork and for deciding as a team on resource allocation (DeShon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004). This *mutual performance monitoring* implies being aware of and keeping track of one's fellow team members' work while carrying out one's own work to ensure that everything is running as expected and all procedures are followed correctly. The more complex a task, which means the greater the number of elements and the higher the degree of interactivity between those elements (Sweller, 1994), the more important mutual performance monitoring probably will be, up to the point where complexity demands overall coordination of complex subtasks executed by sub-teams. If a task is stressful as a consequence of time constraints, mutual performance monitoring is conditional for the team's performance. However, in stressful situations with a team executing a complex task, mutual performance monitoring might not be enough and the need for team leadership probably becomes apparent.

To this end, mutual performance monitoring requires awareness of both task and team aspects and therefore a shared understanding of task and team responsibilities. Only then can it be expected that team members understand what other team members are supposed to be doing. It also requires a dynamic type of awareness similar to the concept of situation awareness, which refers to acquisition and interpretation of information from the environment in order to update and monitor team performance (Endsley, 1995; Leinonen, Järvelä, & Häkkinen, 2005; Salas, Prince, Baker, & Shrestha, 1995). In that sense situation awareness is not only a prerequisite for mutual performance monitoring, it also guarantees its effectiveness. Additionally,

without a shared understanding, feedback becomes inconsequential and monitoring becomes ineffective, which in turn results in low performance (Bolstad & Endsley, 1999; Stout et al., 1999). Also, mutual performance monitoring implies 'participation awareness' and information about team members' activities to be exchanged within the team (Janssen et al., 2007; Kreijns et al., 2003). Another important prerequisite is the existence of trust in a team because only in a climate of trust will members positively and constructively react to feedback and/or critique of other team members. Since mutual performance monitoring is important for team performance as well as team effectiveness, it is hypothesized that mutual performance monitoring is also critical for effectiveness of learning-teams.

Back-up behavior is the ability to anticipate other team members' needs through accurate knowledge about their responsibilities, and includes the ability to shift the workload among members to achieve balance during periods of high workload or pressure (Salas et al., 2005). Adequately shifting the workload between members not only requires knowledge about who is supposed to do what, but also activity awareness (i.e., knowledge about who is doing what) which emphasizes the importance of activity context factors such as planning and coordination (Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003). There are three ways of providing back-up (Marks et al., 2001): Providing feedback and coaching to improve performance, assisting a teammate in performing a task, and completing a subtask for a team member when workoverload is detected. In this sense, back-up behavior has a direct influence on team performance. In a learning-team, inadequate reasons for back-up behavior may appear that do not lead to increased team performance or increased team orientation. When someone takes over a subtask of a team member for reasons of a more personal character and not related to team goals, it may lead to fault-lines within the team and the forming of subgroups, especially when conflicts arise and team communication decreases (Molleman, 2005). In learning-teams carrying out a collaborative learning task, back-up behavior probably is important, especially when interdependence is high. Team mates must back each other up to accomplish common goals. However, back-up behavior only becomes an issue

during the productive phases of teamwork and is also difficult to influence given the fact that it is linked to team orientation and team members' individual attitudes. It is therefore hypothesized that back-up behavior can only be partly influenced in later stages of teamwork and for that reason it is less critical for teams to become effective in an early stage of teamwork.

Adaptability is the ability to adjust strategies based on information gathered from the environment through the use of back-up behavior and reallocation of intra-team resources, or altering a course of action or team repertoire in response to changing internal and external conditions (Salas et al., 2005). It is a team process that moves the team more effectively toward its objectives. This is different from simple flexibility since adaptation should focus on awareness of and assessing changes in the team's task or in the environment to determine if current strategies will be effective in reaching team objectives (i.e., both situation awareness and activity awareness). This implies that members should have a shared understanding of the team objectives and of most effective strategies for reaching them. They should also monitor the team's performance, as well as the performance of its members, to determine if the process is effective or whether adaptations are necessary. Adaptability is important to many types of teams in many situations, but defining the quality of the adaptation in a specific situation is difficult. Adaptability is important when learning-teams carry out a collaborative task, especially when the task is complex and a team can choose between strategies to reach the objectives. However, since task characteristics are usually clear from the start of a learning practice and are not likely to change during the process of teamwork, adaptability will be less needed. Also, it is not very likely that changes in the environment will occur, except when authentic tasks are executed in real professional contexts in the perspective of an internship. The most likely changes that can be expected are changes in team composition and/or team members having problems in carrying out their subtasks. When this is the case, back-up behavior alone should be an adequate solution. It is therefore hypothesized that adaptability is not critical for team effectiveness of learning-teams in early stages of team collaboration.

Building *shared mental models* is considered a supporting and coordinating mechanism during teamwork (Salas et al., 2005). A number of studies have investigated the importance of building shared mental models in teams. Shared mental models are considered to be conditional for setting team goals, deciding on team strategies, allocating subtasks to team members, adequate monitoring of the team processes, and effective communication (Klimoski & Mohammed, 1994; Van den Bossche, Gijselaers, Segers, Woltjer, & Kirschner, 2011). Different concepts are used by different researchers with respect to shared understanding, for instance *team mental models* (Mohammed & Dumville, 2001), *shared mental models* (Stout et al., 1999), *common ground* (Beers et al., 2006), or *synergistic knowledge* (Mu & Gnyawali, 2003). These concepts mainly refer to shared understanding on team level and could be defined as the awareness of team and task aspects in order to become effective as a team. This team and task awareness should be distinguished from 'knowledge awareness' which relates to the knowledge that the team members have to offer and therefore to the individual, situational and team-related parts of shared understanding (Engelmann et al., 2009). To this end, a distinction can be made between team-related and task-related shared mental models and both types have been discussed in relation to work-team performance (Mathieu et al., 2000). In *team-related mental models*, the focus is on the awareness of team functioning and on the expected behaviors of both the team as a whole and the team members individually and in relation to each other. Knowledge awareness is considered to be an aspect of team-related shared mental models and conditional for effective coordination and communication, which in turn results in increased team performance (Engelmann et al., 2009). The focus in *task-related mental models* is on information regarding the materials and strategies needed to successfully carry out the task. Both shared team-related and task-related mental models, or team and task awareness, facilitate task execution by creating a framework that promotes common understanding and action. This does not imply that all team members should have exactly the same understanding, because reaching that level of shared understanding would be very time-consuming and could lead to a reduction of those

alternative perspectives and understanding needed to find new solutions to problems and new ways of executing a task (i.e. *groupthink*; Johnson & Weaver Ii, 1992; P. Jones & Roelofsma, 2000; Paulus, 1998). Each team member must have a mental model regarding task and team aspects similar to the other team members in order to effectively carry out the collaborative task as a team, and these mental models should be negotiated within a team. A sufficient level of dissimilarity is needed within a team regarding the cognitive domain in which the task is situated to improve the team's decision quality and team learning as a result of the input from different perspectives (Kellermanns et al., 2008; Van den Bossche et al., 2006). Being aware of the differences between individual mental models, defined as knowledge awareness, positively effects team performance (Engelmann et al., 2009). Furthermore, similarity and dissimilarity of mental models should be balanced during teamwork and the nature of this balance will probably be different in various stages of teamwork. Also, team members will update their mental models continuously during the process of teamwork. Being aware of team and task aspects and having a shared mental model becomes increasingly important as situations become more stressful, not in the least because communication tends to decrease in those situations. Findings suggest that teams engaged in high-quality planning in early stages of teamwork form better shared mental models during teamwork and perform better, especially when time is running out and situations become stressful (Stout et al., 1999). It is therefore hypothesized that generating shared mental models in early stages of teamwork is critical for the effectiveness of learning-teams.

The importance of *mutual trust* for a team to become effective has been studied in a variety of contexts and types of teamwork (Castleton Partners/TCO, 2007). Without sufficient mutual trust, team members spend too much time and energy protecting, checking, and inspecting each other and each other's behaviors, and too little time constructively collaborating and learning. Mutual trust implies the shared perception that individuals in the team will perform particular actions important to its members and will recognize and protect the rights and interests of all team members. In situations of mutual trust, team members are willing to share information freely and feel safe to do so (Nelson &

Cooprider, 1996). For that reason mutual trust is probably also conditional for building shared mental models since it requires team members sharing information without reservation. If team members work interdependently, they have to accept a certain amount of risk accompanying relying on each other to meet deadlines, contributing to the learning task, and cooperating without subversive intentions. It is hypothesized that mutual trust influences learning-team effectiveness in all stages of teamwork, and especially from early stages on.

The final supporting and coordinating mechanism for work-team performance and work-team effectiveness is *closed-loop communication* (Salas et al., 2005). Closed-loop communication defined as the exchange of information between a sender and a receiver, irrespective of the medium, involves the sender initiating the message, the receiver receiving the message and acknowledging its receipt, and the sender verifying that the receipt-message was received and that the content and meaning was understood as intended. This communication facilitates updating the team's shared mental models, and therefore the awareness of team and task aspects. When the environment increases in complexity, communication becomes more important. In such situations closed-loop communication ensures that sent communications are correctly understood. Communication refers not only to the quality of communication in the perspective of collaborative learning outcomes and/or task execution, but also to the modes of communication. Several studies report no significant differences between computer mediated communication (CMC) and face-to-face communication regarding the outcomes of the process of collaborative learning (Fjermestad, 2004; Ocker & Yaverbaum, 1999). A review of studies on CMC revealed that the effectiveness of CMC also relies on the context and task characteristics (Luppicini, 2007), but there are no reasons to suggest that a specific mode of communication is conditional for team effectiveness. Providing relevant information and supporting awareness by using adequate awareness devices for building a shared understanding leads to the improvement of team performance and emphasizes the importance of the quality of communication in computer supported collaborative work (Fussell et al., 1998).

The purpose of team communication is twofold, namely building both shared mental models and the interpersonal relations within a team. Research showed that the combination of both social and cognitive factors are conditional for effective team learning (Van den Bossche et al., 2006). The importance of communication, more specifically the emotional investment through social interaction on team effectiveness was also found in a study on the role of social exchange (Saavedra & Van Dyne, 1999), though some reservations should be made here, since too much emotional exchange may lead to less effective teams as a result of narrowing the range of accepted ideas (Guzzo & Waters, 1982). Although the importance of closed-loop communication for team effectiveness is clear, measuring the occurrence of closed-loop communication during teamwork does not indicate the level of effectiveness, since only what is communicated when and for what purpose matters. In that sense the effectiveness and adequateness of closed-loop communication is mediated through the quality of shared mental models, mutual trust and mutual performance monitoring, and therefore through the quality of team and task awareness.

Testing the conceptual framework

Combining the aforementioned, the conceptual framework used here can be described as follows (see also Figure 2): Shared mental models, mutual trust, and mutual performance monitoring are key variables during almost all stages of teamwork in learning-teams, and closed-loop communication is an important underlying condition. Team orientation and team leadership are not key variables in the context of learning-teams. Back-up behavior and adaptability are also not key variables, although they could become important during later stages of teamwork of learning-teams.

In the proposed model, mutual trust is an intermediate variable and related to both the team and the task. At the team level (i.e., social dimension), mutual trust focuses on protecting the interests of all members and performing actions important to all members. At the task level (i.e., cognitive dimension), mutual trust is focused on sharing information and feeling free to do so. Mutual trust is conditional for adequate mutual performance monitoring and for preventing the misinterpretation of mutual performance

monitoring. In learning-teams lacking mutual trust, mutual performance monitoring is likely to shift from exchanging relevant information about team aspects and task aspects to spending time checking each other's performance, discussing conflicts, and protecting each other's interests. Also, in learning-teams with low levels of mutual trust, members will tend to communicate more with preferred teammates and less with the team as a whole. The perception of trust at the team level is related to the concept of *psychological safety* (Edmondson, 1999), since team members must feel safe in order to freely exchange information. In that sense, all members should share the same understanding regarding the characteristics of psychological safety in the team.

> *Hypothesis 1: The perception of mutual trust (or psychological safety) is conditional for effective mutual performance monitoring in learning-teams.*

Shared mental models are also considered an intermediate variable in the proposed model. Without a shared mental model of both team and task characteristics, team communication will not develop towards an open exchange of views leading to the emergence of solutions. Shared mental models are also conditional for adequate mutual performance monitoring, because all members' performances need to be interpreted within the same shared perspective; that is the awareness of team aspects and task aspects, requiring team members to make use of the same knowledge about the team and the task at hand.

> *Hypothesis 2: Shared mental models at the team level as well as at the task level are conditional for effective mutual performance monitoring in learning-teams.*

Mutual performance monitoring is seen as an intermediate variable. To adequately monitor the performance of one's team members, information must be freely shared within the team and team members must be aware of contextual conditions and changes in the environment, task aspects and goals, distribution of subtasks and roles within the team, and time constraints. As a consequence, mutual performance monitoring should result in effective task execution in relatively stable situations, provided that

changes in environmental demands as well as workload distribution problems do not occur.

> *Hypothesis 3: Mutual performance monitoring predicts learning-team effectiveness in cases when changes in environmental demands and workload distribution problems do not occur.*

The outcome, and thus the dependent variable in the proposed model is *team effectiveness*. To this end, Hackman's definition of group effectiveness (1990) is used, which distinguishes between group performance, satisfaction of group members, and the ability of a group to exist over time. Although the latter is not particularly relevant in the educational context (i.e., learning-teams usually exist over short, fixed periods of time and new learning-teams with different composition are usually formed for new assignments) expressing a willingness to collaborate again within the same team can be seen as a measure of how the team members perceive the effectiveness of the team. Team effectiveness includes the quality of the team's performance as well as the perceived satisfaction of individual needs of team members. This definition addresses team effectiveness at the team level (i.e., performance) and at the individual level (i.e., team member satisfaction), emphasizing that in teamwork, team goals and individual goals should merge, or at least should be well balanced, if a team is to be effective (Kasl et al., 1997). At the team level, effectiveness is expressed through the quality of performance, which in itself includes quality of the product and of the process. Product quality in the educational context is usually expressed through grading and often refers to the quality of the product and whether a preset deadline has been met. Process quality refers to the balance between time and materials invested versus outcomes achieved as a result of that balance (i.e., efficiency). It also refers to the quality of the collaboration, which is the effective use of a team's expertise and capacity, along with smooth processes of negotiation, decision making and performance monitoring in the team. Connections between the intermediate variables and dependent variable are shown in Figure 3. Matching hypotheses are added with corresponding numbering.

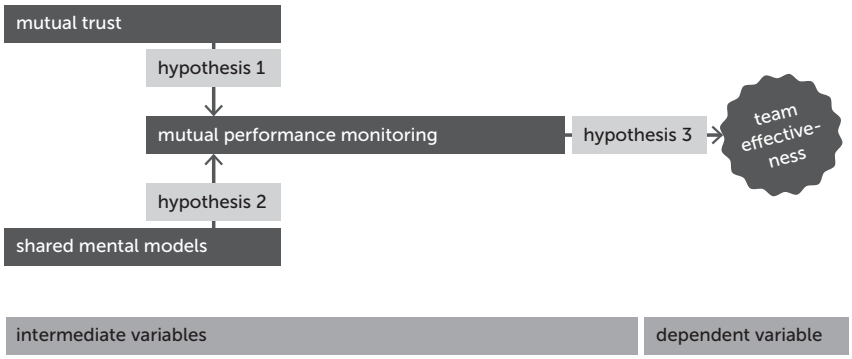

Figure 3
Expected model with the key variables (Intermediate variables) mediating team effectiveness (dependent variable) with hypotheses.

Method

To establish the validity of this model with key variables mediating team effectiveness an experiment was carried out.

Participants | Students (*N* = 116) from the Initial Teacher Training Program of Inholland University of Applied Sciences working on a computer-supported collaborative learning assignment in their fourth and final study year participated in this study. The learning assignment was called '*Schools Are Made by People*' in which teams had to design a new primary school for which they will be the staff. In this way they experience what it means to be a member of a school organization. Being a 'school team', they develop the school's organizational and pedagogical policy and during this process are confronted with problems that schools normally have to deal with. The exercise takes ten weeks to finish and is concluded by producing a written policy paper and a website, followed by an oral presentation to an educational inspector. The teams communicated face-to-face and online, and a virtual learning environment, specifically designed for this assignment (*Mensen Maken Scholen*), was used for exchanging work-in-progress, peer feedback, and publication of results (Vreugdenhil, Moors, & Van der Neut, 2004).

The 116 students were divided over 9 teams ranging from 8 to 16 members each, strongly resembling real team sizes of school teams in smaller primary schools in the Netherlands. Every student operated as a member of this team, but collaborated more intensely in smaller sub-teams in committees determining specific parts of the school's policy. The teams had not worked in the same composition before, although every student had previ-

ously collaborated with one or more of the other team members on assignments in preceding years. This means that, in order to function effectively, all teams needed to develop both team skills and task skills. Eight teams were composed exclusively of students coming from either the full-time program or the part-time program, and one team contained a mixture of students from both programs. Students were informed about the research project and all agreed to cooperate.

Instrumentation | A questionnaire containing 20 items formulated as statements on a 7-point Likert scale (ranging from 'completely disagree' to 'completely agree') was developed for determining the degree of mutual trust, shared mental models, mutual performance monitoring, and team effectiveness. Three items were reversed, and almost every item stems from instruments used and validated in other studies, but slightly adapted to fit the specific context of this study. The questionnaire can be found in Appendix A.

Since no direct measure was found for perception of mutual trust, some items from the 'Psychological Safety' scale in the 'Team Survey Questionnaire' (Edmondson, 1999) were used, augmented with two items derived from the criteria on swift trust/deeper trust in the Scoping Study Report from the Emergency Capacity Building Project (Castleton Partners/TCO, 2007). Mutual trust is assumed to be related to the concept of 'psychological safety' in the sense that psychological safety is conditional for mutual trust to emerge in a team. Internal consistency was acceptable (Cronbach's $\alpha = .68$).

Perception of shared mental models was determined through the use of a number of items extracted from the section 'Clear Direction' of the 'Team Survey Questionnaire' (Edmondson, 1999), and from the 'Team Learning Beliefs & Behaviors – Questionnaire' (Van den Bossche et al., 2006). One item was added, derived from criteria on swift trust/deeper trust in the Scoping Study Report from the Emergency Capacity Building Project (Castleton Partners/TCO, 2007), focusing on the team's vision on roles of members. Internal consistency was high (Cronbach's $\alpha = .81$).

Since mutual performance monitoring aims at improvement of team effectiveness and the quality of results, it is related to the concept of *team learning behavior*. Perception of team learning behavior was measured by using two

items from the 'Team Learning Behavior' scale of the 'Team Survey Questionnaire' (Edmondson, 1999). Performance monitoring becomes more important as interdependence increases. Learning-teams scoring low on perceived interdependence will probably have less reason to frequently communicate on team and task aspects. Measuring perception of interdependence is necessary to corroborate the findings on the other two items on *team learning behavior*, resulting in a deeper insight in mutual performance monitoring. To this end, three items were used from the 'Team Learning Beliefs & Behaviors – Questionnaire' (Van den Bossche et al., 2006). The internal consistency of the resulting five item scale on mutual performance monitoring was sufficient (Cronbach's $\alpha = .68$).

Perceived team effectiveness was measured by using three items previously used in studies on team effectiveness (Chang & Bordia, 2001), and which were also used in the 'Team Learning Beliefs & Behaviors – Questionnaire' (Van den Bossche et al., 2006). Although the existence of a team over time is not an issue in this particular context, the perception of team members of the ability of their team to exist over time might be an indication of team effectiveness, even if the team is dismantled after completing the assignment. The internal consistency was strong (Cronbach's $\alpha = .83$).

A principal component analysis showed the complexity of the construct of mutual trust, resulting in deletion of one item and the shift of three items from the trust scale to the shared mental models scale and the mutual performance monitoring scale. The resulting mutual trust factor focused more on aspects of the resulting trusting behavior. Kaiser-Meyer-Olkin measurement showed acceptable results (KMO = .78) and Bartlett's test was significant ($p < .001$), indicating that results of the factor analysis may be interpreted (Field, 2005). Scores on original scale as well as the resulting factor of the principal component analysis will be used in the data analysis.

Procedure | The questionnaire was presented within two weeks of the deadline for delivering the final products. This choice of delivery moment was based on the assumption that all teams would have reached the final productive phase by that point, but that perceptions about team effectiveness would not be biased by grading and/or a premature onset

of team dismantling. The questionnaire was distributed and collected during a regular meeting with the tutors, resulting in a high response rate (90%). Students were informed that anonymity would be assured and that responding would not influence their grade.

Method of analysis | Regression analyses were performed to test the hypotheses and to identify the nature of the effects of intermediate variables on team effectiveness. Intra-class correlation coefficients were calculated. However, only two of the four variables were significant (i.e., mutual performance monitoring and team effectiveness) and showed a group effect. For this reason and also due to the small number of teams multilevel analyses were not performed (Cress, 2008).

First, the effects of mutual trust and shared mental models on mutual performance monitoring were analyzed in simple regression analyses. Additionally, stepwise multiple regression analyses were carried out to test influences of all intermediate variables on team effectiveness. All residuals were inspected. Regression analyses were also performed with data aggregated on team level to confirm the findings or to identify significant differences in outcomes.

Additionally the re-designed model was tested through Structural Equation Modeling using AMOS 7.0 (Arbuckle, 2006). Results from maximum likelihood estimation were used. The Chi-square statistics, as well as values of the Root Mean squared Residual (RMR), with values < .05 indicating a good fit, the Root Mean Squared Error of Approximation (RMSEA), with values < .05 indicating an excellent fit, and the Adjusted Goodness of Fit Index (AGFI), with values > .90 indicating a good or excellent fit, were examined.

Results

No significant effect of mutual trust (M = 5.27, SD = .90) on mutual performance monitoring (M = 5.36, SD = 1.19) was found and as a result hypothesis 1 was rejected.

A small but significant effect of shared mental models (M = 5.21, SD = .95) on mutual performance monitoring was found (β = .268; R^2 = .072; p < .05) which did not change when mutual trust was added to the model. Therefore hypothesis 2 was accepted, although the effect is considered limited.

These findings are supported by the results of the analysis of the effect of mutual performance monitoring on team effectiveness (M = 5.77, SD = .98), which is also limited (β = .264; R^2 = .069; p < .05). Hypothesis 3 is accepted, but the findings suggest that mutual performance monitoring contributes to team effectiveness in a limited way. A considerable effect of shared mental models on team effectiveness was found (β = .622; R^2 = .380; p < .001), suggesting that shared mental models are more important than mutual performance monitoring for a team to become effective. Since the correlation between mutual trust and shared mental models was significant (r = .631), an additional regression analysis was executed to explore the effect of mutual trust on shared mental models. The results showed a substantial effect (β = .631; R^2 = .392; p < .001), which emphasized that mutual trust appears to be conditional for shared mental models to emerge in a team, and supported the assumption that the effect of mutual trust on mutual performance monitoring might be mediated through shared mental models. Table 1 shows the results of the separate regression analyses.

Table 1
Results of separate regression analyses.

	Shared Mental Models	Mutual Performance Monitoring	Team Effectiveness
Mutual Trust	β = .631; t = 8.210; $adj.R^2$ = .392**		
Shared Mental Models		β = .268; t = 2.812; $adj.R^2$ = .072*	β = .622; t = 8.016; $adj.R^2$ = .380**
Mutual Performance Monitoring			β = .264; t = 2.759; $adj.R^2$ = .069*

* p < .05; ** p < .001

A stepwise regression analysis exploring partial effects of intermediate variables on team effectiveness, as well as the overall effects of the intermediate variables on team effectiveness, confirmed the major effect of shared mental models on team effectiveness, since the effects of mutual trust and mutual performance monitoring on team effectiveness became insignificant when shared mental models was entered in the model. The effect of mutual trust on team effectiveness is, thus, mediated through shared mental models. The effects were analyzed on the whole sample

as well as at team level. Since the results were similar, further analysis of the data at team level was not carried out.

Regression analyses performed on the factors produced by the principal component analysis confirmed the importance of shared mental models, although its effect was partly mediated through mutual performance monitoring (Table 2).

Model (+ adjusted R2)		**Team Effectiveness**
1 (*adj.*R^2 = - .007)	Mutual Trust 'factor' (trusting behavior)	-
2 (*adj.*R^2 = .410)	Mutual Trust 'factor' (trusting behavior)	-
	Shared Mental Models 'factor'	β = .690; *t* = 8.549**
3 (*adj.*R^2 = .486)	Mutual Trust 'factor' (trusting behavior)	-
	Shared Mental Models 'factor'	β = .512; *t* = 5.859*
	Mutual Performance Monitoring 'factor'	β = .342; *t* = 3.994*

* $p < .05$; ** $p < .001$

Table 2

Results of stepwise regression analysis on factors from the principal component analysis.

The results of the regression analyses require a re-specification of the model, showing a change in position of mutual trust which does not directly predict effective mutual performance monitoring and team effectiveness. See Figure 4 for the adjusted model (i.e., core aspects of the conceptual framework) and effect sizes based on the factors of the principal component analysis.

Testing this model with AMOS 5.0 confirmed the findings of the regression analyses and the likeliness of the redesigned model (X^2 = 3.681 with p = .159 and X^2/df = 1.841, RMR = .057, RMSEA = .090, AGFI = .914). The results from the structural equation modeling show a possible fit of the model to the data (Kelloway, 1998).

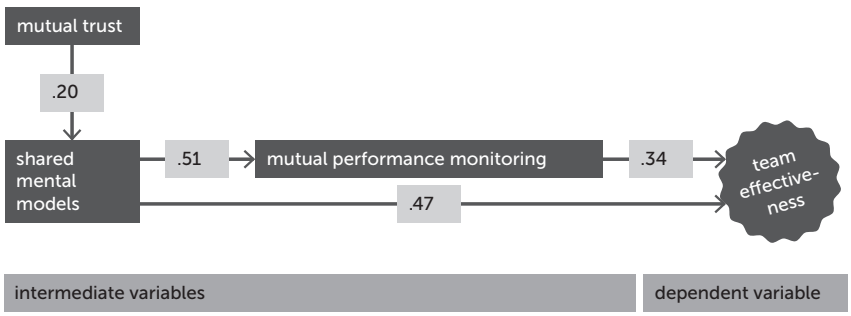

Figure 4

Effect sizes on the basis of factors from the principal component analysis and consequences for the model regarding influences on team effectiveness.

Conclusions

Findings in this study support the assumption that learning-teams perceive themselves as more effective when shared mental models increase and mutual performance monitoring is adequate. In other words, learning-teams need to be aware of team and task aspects in order to become effective. Although adequate mutual performance monitoring is important, the basis lies with building shared mental models and continuously updating those mental models during the collaboration process. It is interesting to note that the effect of mutual trust on mutual performance monitoring and team effectiveness is not significant, though trust seems to be conditional for building shared mental models.

A noteworthy result is that psychological safety does not seem to be as similar to mutual trust as originally thought. Psychological safety might better be interpreted as conditional for the creation of mutual trust in a learning-team and as such, defined as the 'initial interpersonal trust' necessary for developing shared mental models, and thus, for team maturation. The concept of 'initial interpersonal trust' is similar to the concept of 'swift trust' (Castleton Partners/TCO, 2007) which means that the level of initial trust in teams might be measured in early stages of teamwork by investigating aspects related to swift trust. Deeper levels of trust are more likely to emerge during the team's maturation, leading to increased effectiveness. Mutual trust, in that sense, is more an aspect of an effective learning-team after successfully completing a task.

Results regarding mutual trust also emphasize the complexity of trust as a construct (Watson, 2005). Trust appears to be a multidimensional construct, reflected by the abundance of research-based concepts such as calculus-based trust and identification-based trust (Lewicki & Bunker, 1996), trustworthiness and trusting behavior (Tanis & Postmes, 2005), swift trust and deeper trust (Castleton Partners/TCO, 2007), or affect-based trust versus cognition-based trust (McAllister, 1995). Some research also suggests that trust may be context-dependent (Olekalns, Lau, & Smith, 2007), which means that operationalizing it would depend on the context in which it needs to be developed. Given this probable context-specificity of trust, our findings suggest that the effect of trust on learning-team effectiveness is negligible, and only a limited effect of swift trust can be

expected. This specific type of trust could be defined as cognitive-based trust (Greenberg et al., 2007). These findings are similar to findings in research on trust in virtual teams where trust was mainly based on 'perceived ability and integrity' and did not significantly influence team performance, but the existence of initial trust appeared to result in teams suffering fewer 'process losses' and in collaborating more effectively as a result (Aubert & Kelsey, 2003). Further research using a longitudinal design and an emphasis on qualitative measurements is necessary to confirm these assumptions and to investigate the complexity of mutual trust in learning-teams.

The need for initial interpersonal trust, and more specifically mutual expectations about team member reliability on the task-level, supports the assumption that learning-teams act pragmatically. These teams must deliver results in short periods of time, they often experience competition with other tasks that must be carried out in other courses during the same period, and they are usually dismantled after the assignment is completed. This pragmatic approach is strengthened by grading, since students tend to focus on getting good grades and preferably with minimal effort (Mao & Zakrajsek, 1993). Focusing on the task aspects of performance is by far the most efficient choice in such circumstances. This has been demonstrated in studies on short-term teams (Bradley et al., 2003; Druskat & Kayes, 2000), where teams tend to redirect conflicts to the task-level, hoping that they can be easily and efficiently solved. Research on virtual teams showed that lack of trust and redirecting conflicts to the task-level resulted in an increase in 'process losses' and in teams needing more time to deliver results (Aubert & Kelsey, 2003). These interpretations were presented to the students who participated in the research in a plenary debriefing session. In that session, students stated that their shared mental models and awareness were primarily task-based, although teams also reported that knowing each other better sped up the process of building shared mental models and of reaching agreement on goals and strategies. Students admitted that this pragmatic stance, though understandable and not always effective, is not perceived by them as exceptional in practices of collaborative learning.

The finding that the effect of shared mental models was more important than mutual performance monitoring on perceived team effectiveness might be explained by the fact that teams used inadequate procedures and methods for monitoring and giving feedback. The students in the plenary debriefing session reported missing a 'quality watchdog' in their team or having not agreed on how to use the virtual learning environment for performance monitoring and feedback processes, on who delivers feedback when and in what way, and how to deal with it accordingly. Also, agreements on deadlines were not properly made or maintained. This lack of good procedures for mutual performance monitoring seemed to be partly compensated by awareness of team and task aspects in the initial stages, that is the presence of sound shared mental models, suggesting that when team members initially know what to do, how to do it, and who can do what, consultation and discussion during team collaboration can be minimized. This also saves time, which is likely to be attractive since the teams have time constraints. To this end, roles within the learning-team could be assigned (i.e., by the tutor or by the team itself) to facilitate and support effective mutual performance monitoring. Scripting of the monitoring procedures could enhance this even further (Gweon, Rosé, Carey, & Zaiss, 2006; Järvelä, Näykki, Laru, & Luokkanen, 2007; King, 2007). Research on assigned or acquired roles within learning-teams in CSCL showed positive effects on team effectiveness (Kollar, Fischer, & Hesse, 2006; Schellens, Van Keer, & Valcke, 2005; Strijbos et al., 2007).

The limited effect of mutual performance monitoring on perceived team effectiveness might be the result of how mutual performance monitoring was operationalized. This was also indicated by the principal component analysis, since items loading on the factor identified as mutual performance monitoring differed in some respects from items in the original scale. Probably a distinction should be made between 'explicit performance monitoring' and 'implicit performance monitoring'. Explicit performance monitoring is expected as a result of shared mental models and agreements on performance monitoring on quality control, and effectuated by team communication. Implicit performance monitoring can be defined as team members taking action without concomitant communication as a

result of the perception of the awareness of the current team situation at a specific stage in the process. In the latter case team members dynamically adjust their behavior as a result of anticipation and on the basis of the team's situated cognition and shared mental models, in other words the situated awareness of team and task aspects. This specific type of monitoring is also called 'implicit coordination' (Rico, Sánchez-Manzanares, Gil, & Gibson, 2008) and holds that a team is likely to show implicit coordination if all team members share a dynamic and accurate understanding of a current situation and know what has to be done. It is possible that we measured aspects of 'explicit coordination' while teams were more involved in 'implicit coordination'. The importance of situated cognition, team mental situations, and implicit coordination as described by Rico et al. (2008) in learning-teams, might be worth investigating, probably also through analyzing video registrations of teams in action.

The results of this study support the existence of the intermediate variables in our conceptual framework and for their influences on the perceived team effectiveness, although effect sizes and directions seem to differ from expected sizes and directions. It should be emphasized that we used perceived team effectiveness and did not measure team effectiveness directly by testing learning outcomes and/or grading by the teachers. There were two major reasons for this, both seated in the fact that the assignment was a real one in an ecologically valid educational setting. First, the researchers did not have access to the products that teams delivered and therefore analysis and assessment of learning outcomes could not be carried out. Second, there were no unequivocal assessment criteria for the collaborative learning task, and six teachers assessed the products, with each team assessed by only the teacher assigned to the team. This made grading highly subjective and uncontrollable and was thus rejected as reliable data to determine whether the perceived team effectiveness correlated with the actual team effectiveness. Future research should focus on direct measurements of team effectiveness, for instance by measuring the quality of the learning outcomes. Nevertheless, it may be assumed that investing in the creation and strengthening of interpersonal trust and shared mental models on the task-level are

important for team effectiveness, as is the team's investment in adequate monitoring and feedback procedures. Shared mental models seem to be the most important variable, which means that supporting its development in early phases of teamwork is probably the most important intervention to perform in order to establish sufficient levels of team and task awareness in the early stages of teamwork in collaborative learning.

CHAPTER 4

Team Effectiveness in Collaborative Learning: Exploring Learning-Team Maturation[3]

3 This chapter is based on: Fransen, J., Kirschner, P., & Erkens, G. (submitted). Team effectiveness in collaborative learning: Mediating variables and team development.

Collaborative learning is based upon a social-constructivist paradigm in which knowledge construction is seen as either the focus or a side effect of its use. The quality of learning collaboratively depends on the quality of team collaboration and learning-team effectiveness. Based on a validated learning-team effectiveness framework, four case studies and a cross-case analysis were carried out to explore relations between team characteristics, team development, and variables mediating team effectiveness. Data were collected in different stages of teamwork using questionnaires and team interviews. Results show that developing task-related and team-related skills in initial stages of collaboration seems to be conditional for learning-teams becoming effective. This implies the development of a task-related and team-related shared mental model and establishment of a sufficient level of initial trust. Learning-teams need to balance a focus on task-related skills and team-related skills for adequately monitoring teamwork and for effectively adapting to changing circumstances.

Introduction

In the information age and networked world expectations of higher education are rising and learning collaboratively in so-called communities of inquiry to facilitate the construction of personally meaningful and socially valid knowledge is considered an important pedagogical approach (Garrison & Anderson, 2003; Garrison & Cleveland-Innes, 2005). For meaningful collaborative learning, students must become involved in a process of knowledge construction through reflection and discussion resulting in deep learning, deep understanding and ultimately conceptual change (Bereiter, 2002; Bruffee, 1993; Geelan, 1997) To achieve this, learners need to work with conceptual artifacts on the basis of open assignments with built-in interdependency (Blumenfeld et al., 1996).

In this context, team effectiveness influences the quality of learning outcomes (i.e., deep learning and conceptual change; (Salomon & Globerson, 1989), and therefore is a function of the quality of a team's performance and the perceived fulfillment of the individual team members' needs (Hackman, 1990). This team effectiveness may be influenced by learning style or cognitive ability of the team members (Alfonseca et al., 2006; Webb & Palincsar, 1996), decision-making style and intra-group interaction (Hirokawa et al., 2003), and leadership or role assignment in the teams (Johnson et al., 2002; Strijbos et al., 2004).

Research on team effectiveness has predominantly focused on long-term work-teams in organizational settings where learning is a byproduct of collaborating. The extent to which this research informs the research on student learning-team effectiveness was explored and resulted in a conceptual framework of variables mediating learning-team effectiveness within the perspective of learning-team development (Fransen, Weinberger, & Kirschner, accepted). The validity of the core aspects of this conceptual framework was tested, confirming the importance of team and task awareness for effective learning-teams (Fransen, Kirschner, & Erkens, 2011). The framework's developmental perspective, however, was not explored. Here, four case studies and a cross-case analysis were carried out to (1) establish the importance of mediating variables in different stages of teamwork and (2) explore the relations between these variables, learning-team development and the emergence of

team effectiveness within the perspective of learning-team characteristics, and with learning-team effectiveness considered a predictor for effective learning and for the quality of learning results. This investigation marks the beginning of a qualitative approach in the research to further explore and also explain the emergence of learning-team effectiveness in practices of collaborative learning in higher education. This chapter reports on a study aimed at investigating learning-team development predominantly from an insider perspective.

Conceptual framework

Frameworks on team effectiveness developed in the context of work-teams are not fully applicable for learning-teams in educational settings. Starting with a meta-analysis of research on team performance and effectiveness in work-team settings (Salas et al., 2005), Fransen et al. (accepted) developed a framework consisting of three of the 'Big Five' factors (Salas et al., 2005) influencing team effectiveness (i.e., mutual performance monitoring, back-up behavior, adaptability) along with three supporting and coordinating mechanisms (i.e., shared mental models, mutual trust, closed-loop communication) (See Figure 5).

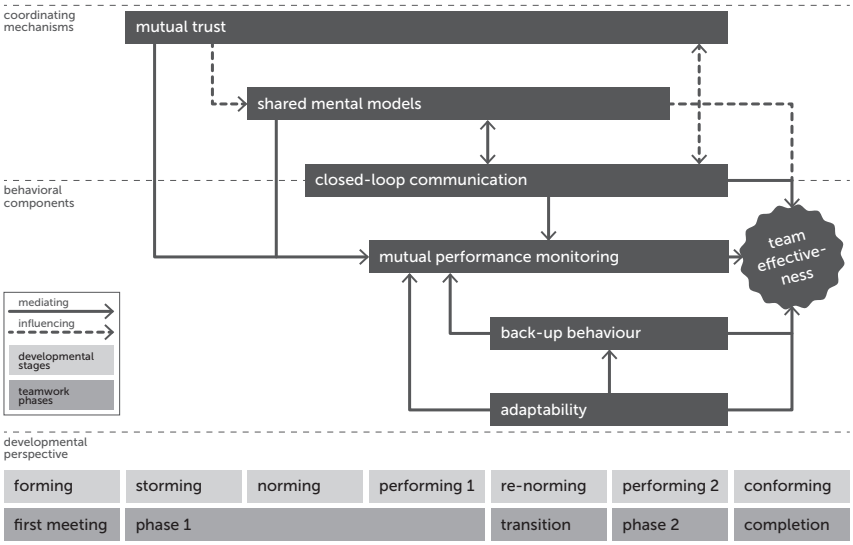

Figure 5

Framework with variables influencing or mediating learning-team effectiveness positioned within the perspective of learning-team development.

Teams must develop *shared mental models* in order to set team goals, determine strategies, allocate subtasks to team members, monitor team processes, and effectively communicate (Klimoski & Mohammed, 1994; Salas et al., 2005; Van den Bossche, 2006). Learning-teams, like work-teams, must develop a team-related and task-related shared mental model early in collaboration to become productive and deliver results, but learning-teams tend to focus on the task and not the team, and act pragmatically (Fransen et al., 2011). Developing a shared mental model of goals and strategies is important especially when teams must produce a collaborative product (e.g., project-based learning), but shared mental models are at the same time the outcomes of collaborative learning in practices aimed at knowledge construction. In that case, team members' knowledge should converge on task aspects (i.e. goals and strategies) and team aspects (i.e., transactive knowledge), but diverge on the individual knowledge that each team member has to offer (Weinberger et al., 2007).

Mutual trust implies the shared perception that every individual in the team will perform particular actions important to the team and protect the rights and interests of all members (Salas et al., 2005). Findings suggest that trust has a limited effect on learning-team effectiveness, since ad-hoc short-lived learning-teams often operate in a pragmatic and task-oriented way and only minimal levels of cognition-based trust (McAllister, 1995) appear to be necessary (Fransen et al., 2011). However, since learning-teams usually have no influence on environmental factors mediating their performance, team members depend strongly on each other to work on a task (Chiocchio & Essiembre, 2009). Also, companion-based trust (i.e., trust based on emotional bonds) may interfere with cognition-based trust if students develop friendships as a result of being classmates, which may lead to fault-lines within the team as a result of someone taking over a team member's subtask for reasons of a personal character and not related to the team goals (Molleman, 2005). Additionally, a meta-analysis on the impact of conflicts within a team on team effectiveness showed that both task conflicts and team conflicts negatively influence team effectiveness (De Dreu & Weingart, 2003). This meta-analysis showed that task conflicts and relationship conflicts are strongly correlated in teams with low mutual trust, which implies that

minor conflicts on the cognitive level, which are considered conditional for collaborative learning, may probably negatively influence team effectiveness in learning-teams lacking a minimal level of initial trust and also suffering from relational conflicts. Finally, although mutual trust seems to be of limited importance, the impact of trust may be mediated by task-complexity, which implies that complex tasks require both distributed knowledge and team members asking fellow team members to deal with emerging new information and knowledge in order to develop the team's transactive memory, which is conditional for successfully completing the task. This implies that initial trust must established since one has to rely on each-other to be successful as a team (Akgün, Byrne, Keskin, Lynn, & Imamoglu, 2005).

Communication (i.e., information exchange between sender and receiver) facilitates updating the team's shared mental model (Salas et al., 2005). This is especially important when the environment increases in complexity, implying that communication should have a closed-loop character. Closed-loop communication involves the sender initiating the message, the receiver receiving the message and acknowledging its receipt, and the sender verifying that the receipt-message was received and the content and meaning was understood as intended (P. Kirschner et al., 2008). Collaborative-learning assignments usually are complex and students lack the expertise to imagine elaborate outcomes at the start and have to establish a shared purpose through knowledge of each-others' competences. They also have to create ownership of the task (Tolmie & Boyle, 2000) and a sense of community (Wegerif, 1998) through communication.

Regarding the behavioral components, *mutual performance monitoring* allows team members to follow each-others' work while carrying out their own work to ensure that all is running as expected and procedures are followed correctly (Salas et al., 2005). In collaborative learning practices mutual performance monitoring is less focused on following each-others' work, but more on the interaction between learners and the learning process (Dillenbourg et al., 1996).

Back-up behavior is the ability to anticipate other team members' needs through accurate knowledge of their responsibilities and to shift the workload among mem-

bers to achieve balance during periods of high workload or pressure (Salas et al., 2005). Back-up behavior in learning-teams may be counterproductive when it is a response to "free-riding" or social loafing, which then results in contributing to the final results is left to the more motivated members in the team (Salomon & Globerson, 1989).

Adaptability is the ability of a person or a group to adjust the strategies through back up behavior and reallocation of the intra-team resources, or by altering a course of action or team repertoire in response to changing internal and external conditions based on information gathered from the environment (Salas et al., 2005). With respect to learning-teams, adaptability is not an issue in the context of knowledge construction, since a learning-team may not have to adapt to changing conditions, yet benefit from a costly and time-consuming process (Kapur & Kinzer, 2007). Adaptability, however, is relevant when executing a problem-based or project-based learning task.

Team effectiveness, as dependent variable in the framework, includes the quality of the team's performance and the perceived satisfying of individual team members' needs. In the complete conceptual framework (See Figure 6) the variables mediating team effectiveness are presented within the perspective of team development and the phases of team work, which was derived from the Team Evolution And Maturation (TEAM) model of group development (Morgan et al., 2001), since the influence of the variables discussed will likely differ according to the phase of teamwork, since – for example – without a sufficiently shared mental model early on in the process, it is unlikely that a team will become productive and effective. The TEAM model describes a set of developmental stages (as does Tuckman's stages model; Tuckman & Jensen, 1977), but teams do not have to proceed through all stages and may start at different stages, according to past experiences of the team and its members, as is the case in the punctuated equilibrium model (Gersick, 1988). Deadlines and the task at hand influence team development and teams usually experience a transition stage (i.e., re-norming) about half way to the deadline. Teams that did not perform well will then start performing in order to deliver results on time and teams that did perform well tend to change this performance towards more practical and goal-oriented performance. The TEAM model has two paths along which a team develops:

a task-related path (e.g., reaching agreement on goals and strategies, developing solutions and delivering results) and a team-related path (e.g., developing group cohesion and role-relatedness, and fulfillment of the roles).

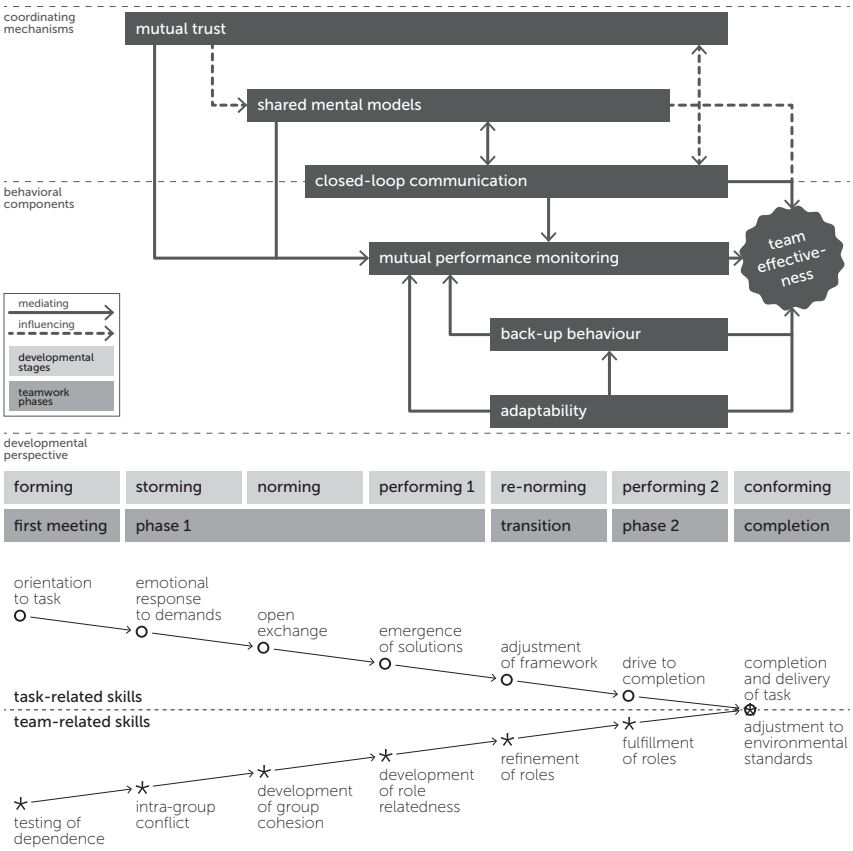

Figure 6

Conceptual framework on learning-team effectiveness presenting variables mediating team effectiveness in the perspective of team development and maturation.

The core aspects of this conceptual framework were tested to establish its value for future research on influencing learning-team effectiveness (Fransen et al., 2011). Results confirmed the importance of shared mental models, and to some extent mutual performance monitoring, for a learning-team to become effective. The developmental perspective, however, needs further exploration. To this end, four case studies and a cross-case analysis were carried out to establish patterns in learning-team development, addressing (1) the importance of the different variables mediating learning-team effectiveness in different stages of learning-team development and (2) how this relates to team characteristics.

Method

Participants in the four case studies, the instrumentation, procedures and data analysis are being reported here.

Participants | Students (N = 15; eight males/seven females, mean age = 39.6, SD = 5.6) from a master program on learning & innovation working on collaborative assignments in their final study year participated as part of a required course. They received no remuneration for participation. Students had a say in team formation, since teams were composed on the basis of shared interest in subject and/or type of assignment. Three project assignment choices were offered and students could also propose a project themselves. The projects took one full semester to complete (4 hours per week for 20 weeks). The teams communicated face-to-face and online, and team spaces were offered within a virtual learning environment to facilitate exchanging work-in-progress, peer feedback, and publication of results. Each team had its own chat-area and forum, exclusively accessible to the team. Students were divided over four teams of 3-5 members. The teams had not worked in this composition before. The students were informed about the research and all agreed to take part.

Instrumentation | Three instruments were used to investigate the emergence of team effectiveness from an insider perspective.

Team Effectiveness Questionnaire | A questionnaire containing 34 items formulated as statements on a 7-point Likert scale (ranging from 'completely disagree' to 'completely agree') was developed for determining the degree of perceived mutual trust, shared mental models, mutual performance monitoring, back-up behavior, adaptability, and team effectiveness. The questionnaire was specifically developed for this purpose and is an improved version of the 'team effectiveness questionnaire' used in the validation procedure of the conceptual framework (Fransen et al., 2011) as reported in chapter 3. A total of 20 items stem from instruments used and validated in other studies, but adapted to fit the specific context of this study. New items were added based on the outcomes of team interviews held during the validation study. The questionnaire was presented to two researchers in the field of collaborative learning for expert appraisal and tested with five students. The resulting 34-item questionnaire was validated by pre-

senting it online to students from the university's Initial Teacher Training program, recently involved in collaborative learning activities. Within ten days, 161 students responded. The improved and validated Team Effectiveness Questionnaire consists of five scales and can be found in Appendix B.

For the perception of mutual trust, three items from the 'Psychological Safety' scale in the 'Team Survey Questionnaire' (Edmondson, 1999) were used, supplemented with five new items derived from interviews with student teams. Internal consistency on the 8-item scale was high (Cronbach's $\alpha = .85$).

Perception of shared mental models was determined through the use of items from the 'Team Survey Questionnaire' (Edmondson, 1999), and from the 'Team Learning Beliefs & Behaviors – Questionnaire' (Van den Bossche et al., 2006), supplemented with items derived from the interviews with student teams. Internal consistency on the 8-item scale was excellent (Cronbach's $\alpha = .92$).

The perception of mutual performance monitoring was measured by using items from the 'Team Survey Questionnaire' (Edmondson, 1999). Also, three items for measuring perceived interdependence were used from the 'Team Learning Beliefs & Behaviors -Questionnaire' (Van den Bossche et al., 2006). The scale was supplemented with two items on closed-loop communication and two items on planning and decision making derived from team interviews. The internal consistency of the resulting 10-item scale was excellent (Cronbach's $\alpha = .91$).

Back-up behavior and *adaptability* were measured on the basis of four items stemming from the 'Team Learning Beliefs & Behaviors – Questionnaire' (Van den Bossche et al., 2006), supplemented with items derived from team interviews. Internal consistency on the 6-item scale was high (Cronbach's $\alpha = .79$).

Perceived team effectiveness was measured with three items previously used in studies on team effectiveness (Chang & Bordia, 2001), which were also used in the 'Team Learning Beliefs & Behaviors – Questionnaire' (Van den Bossche et al., 2006). This scale was supplemented with one item derived from the team interviews. The internal consistency on the 4-item scale was excellent (Cronbach's $\alpha = .92$).

Team Collaboration Evaluator | The Team Collaboration Evaluator was developed to measure the perceived quality of team collaboration in different stages of teamwork. It was derived from the improved Team Effectiveness Questionnaire by selecting 12 items from the scales on shared mental models, mutual trust, mutual performance monitoring, and perceived team effectiveness which cover main aspects and are highly correlated to these variables. The statements were rephrased into questions and respondents are asked to rate their team on a scale from 1 to 10 on these aspects, based on the perception of the quality of team collaboration until that moment. The 12 items refer to the following factors and coordinating mechanisms:

- 1, 2, & 3: Shared Mental Models (SMM)
- 4, 5, & 6: Mutual Trust (MTR)
- 7, 8, & 9: Mutual Performance Monitoring (MPM)
- 10, 11 & 12: Perceived Team Effectiveness (PTE)

Internal consistency was good to excellent: shared mental models (Cronbach's $\alpha = .87$), mutual trust (Cronbach's $\alpha = .80$), mutual performance monitoring (Cronbach's $\alpha = .89$), perceived team effectiveness (Cronbach's $\alpha = .91$). An open question was added asking students to report one incident that they perceived as being important for improving team collaboration during the past period of teamwork. The Team Collaboration Evaluator can be found in Appendix C.

Team interview | All four teams were interviewed after task completion by using both a questionnaire for individually interviewing team members, and a group interview. Team members were asked to complete the online questionnaire with 40 questions on four topics (i.e., task characteristics, task approach, team trust, and performance monitoring) a week before the group interview. The questionnaire – based on the interview protocol – explored individual opinions on conditions for effective team collaboration and the extent to which these conditions existed in the teamwork assignment just completed. By first administering the questionnaire, the actual interview could be limited to 1-hour for each team. The group interview was carried out with the help of an electronic support system (ZING; http://www.anyzing.com/). Each team member has a keyboard to

answer questions and all answers are projected on screen for a group discussion. The ZING strategy guarantees equal participation of all team members during the team interview and produces a full transcript. The responses were analyzed to explore patterns in the responses of the members of each team. The online questionnaire can be found in Appendix D, the team-interview protocol can be found in Appendix E.

Team performance | Results of the teamwork were assessed using a list of 12 assessment criteria developed with the students. These criteria were categorized into six aspects (i.e., subject relevance, elaboration quality, theoretical quality, result quality, critical reflection, presentation quality), each resulting in a score. The scores on these 12 aspects added up to a maximum of 100 and dividing the final score by 10 produced the final grade. Team results were evaluated by the researcher and one independent assessor and corresponded for 83.8% (Cohen's kappa = .69). The assessment form can be found in Appendix F.

Procedure | The Team Effectiveness Questionnaire was twice presented online during the semester; at mid-term and one week before the deadline. The Team Collaboration Evaluator was presented online to all students at four different stages of teamwork at an interval of about 5-6 weeks, the first time two weeks after starting the assignment and the last time one week before the deadline. The extra questionnaire for the team interview was presented three days before the team interview which was carried out after the presentation of the team results. Response rates were 100% on all questionnaires after sending personal reminders. Students were assured of their privacy and that responding would not influence their grade. One student missed the team interview due to personal reasons not related to the research. All students received a small present after completing the team interview, though this was not known to them prior to the study.

Data analysis | Data were analyzed on team level, and since team development was measured by offering the Team Collaboration Evaluator at four different stages of teamwork, patterns in distribution of team-members' perceptions regarding the variables mediating team effectiveness were explored. Results of these four measurements were compared with findings of the Team Effectiveness Questionnaire and the team inter-

view to confirm these patterns. Patterns were explained using qualitative data from open questions in the questionnaires. A cross-case analysis was carried out to compare the teams on tem development patterns with respect to team effectiveness to explore the relations between the mediating variables, team development and team effectiveness.

Results

The four case studies are reported first, presenting the findings of the Team Effectiveness Questionnaire, the Team Collaboration Evaluator, and the team interview, followed by the cross-case analysis.

Case 1 – Team A | Team A (two males, two females) organized a field trip for the master program, including a visit to a relevant international conference. The team had to determine the trip's program and organization (i.e., travel advice, hotel bookings, transport during the visit). Team formation was based on the team members' shared interest for the assignment. Team A received a grade of 7.2 for their final product.

Results from the Team Effectiveness Questionnaire of the mid-term evaluation show that all members are relatively satisfied with how the team is operating (i.e., scores on all scales are above 6.2), and distribution in scores on all scales is limited (.34 < *SD* < .43). Only the scores on items 'a shared vision on strategies' and 'taking time for quality control' were low in stage 2, which confirms the results of the Team Collaboration Evaluator. Scores on almost every item are lower and more distributed in the final evaluation on 'mutual trust', and on 'mutual performance monitoring'. Scores on the item 'dependent on each other to carry out the task' are especially low. The mean scores and the distribution on all scales in the mid-term evaluation and the final evaluation are presented in Table 3.

Team Effectiveness Questionnaire	Mid-Term Evaluation	Final Evaluation
Shared Mental Models	*M* = 6.25, *SD* = .34	*M* = 5.81, *SD* = .58
Mutual Trust	*M* = 6.50, *SD* = .31	*M* = 5.69, *SD* = .43
Mutual Performance Monitoring	*M* = 6.23, *SD* = .21	*M* = 5.30, *SD* = .36
Perceived Team Effectiveness	*M* = 6.43, *SD* = .43	*M* = 6.06, *SD* = .31

Table 3

Mean scores and distribution on the scales of the Team Effectiveness Questionnaire in the mid-term and final evaluation of Team A.

Results of the Team Collaboration Evaluator show a relatively limited variation in the scores on 'shared mental models', although scores are initially rather low and gradually rise in the next stages (See Figure 7). The results also show relatively high initial scores on 'mutual trust' and scores gradually rising in the next stages. Scores on 'mutual performance monitoring' are relatively low in the first stage, but clearly rise in the next stages, although scores are more distributed in stage 2 and in stage 4. Scores on 'perceived team effectiveness' are relatively low and distributed in stage 1, with scores gradually rising and becoming less distributed in subsequent stages. Scores on all four factors show an increase in satisfaction about team collaboration through the stages. The increase is most evident in stage 2 on 'mutual trust' and 'mutual performance monitoring', although distribution increases, suggesting that team members do not fully agree on how teamwork is being monitored. The increase in satisfaction is more evident on all aspects in stage 3, and scores stabilize in the final stage. Distribution increases in the last stage on perceived quality of communication and team members disagree on the assignment being carried out as was agreed.

The team interview as well as the preliminary extra questionnaire used as preparation for the interview, confirms these findings. Team members divided subtasks in a very early stage and some problems were reported regarding information exchange within the team, as was mentioned by one team member:

> *"We probably were with too many for carrying out the task, therefore we frequently had to discuss this and many contributions to these discussions were not relevant."*

This resulted in unnecessary email-exchanges and time-consuming meetings or repair activities to solve emerging problems. Team members preferred communicating face-to-face and chat communication was not highly valued:

> *"It takes too long before reactions of others appear on the screen which is why discussions in a chat meeting are usually very chaotic."*

It is noteworthy that team members perceived the assignment as purely organizational and not as complex enough to justify collaborative learning. While the assignment also implied preparing the trip's program, the assignment was interpreted as mainly organizing transportation and accommodations. Team members perceived fellow team members as agreeable, but team collaboration was not seen as efficient:

> *"The assignment probably would have taken the same amount of time if I had done it alone, mainly because team meetings and communication were not always effective"*

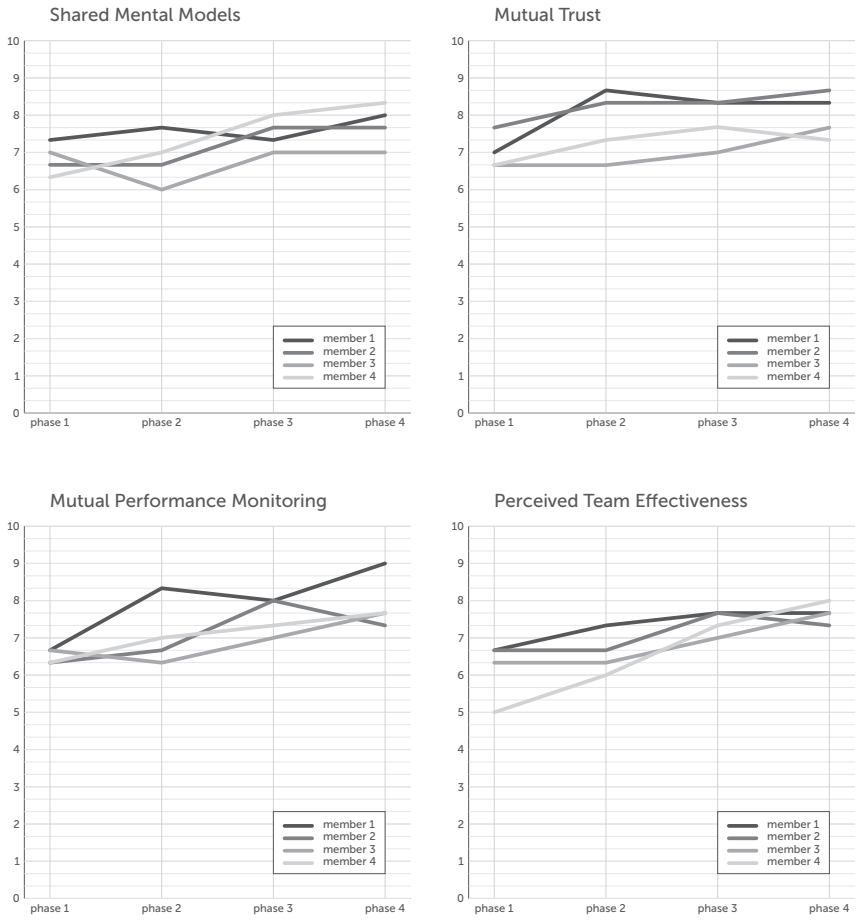

Figure 7.

Results of Team A on the Team Collaboration Evaluator in four phases of teamwork.

Teamwork results were mediocre, as reflected by the scores and feedback on the academic quality of the results. The team focused on the organizational aspects of the field trip with program preparation limited and program options not well investigated. Only the relevance of this kind of trip was explored and accounted for. Team communication often failed, resulting in organizational problems that had to be solved during the trip.

It can be concluded that – based on sufficient levels of mutual trust and given the combination of diverse qualities – the team decided to divide the task into subtasks in an early stage. Since procedures for mutual performance monitoring were not discussed and not thought through, team communication was not effective, a result which was enhanced by inadequate media choice. Final results were delivered just before the deadline and since the assignment was not interpreted as it should have been, final outcomes were mediocre (i.e., final grade = 7.2).

Case 2 – Team B | Team B (three males) organized a symposium with respect to content (i.e., relevant program, inviting a keynote speaker) and organization (i.e., location, registration, catering). Team formation was based on team members' shared interest for this assignment. Team B received a grade of 7.6 for their final product.

Results from the Team Effectiveness Questionnaire of the mid-term evaluation show that all members were satisfied with how the team operated. The score distribution is limited on all scales, especially on 'shared mental models'. Results of the final evaluation show a small increase in perceived quality on every scale, and the scores less distributed on 'mutual performance monitoring' and perceived team effectiveness. Mean scores and the distribution of the scores on all scales in the mid-term evaluation and final evaluation are presented in Table 4.

Team Effectiveness Questionnaire	Mid-Term Evaluation	Final Evaluation
Shared Mental Models	M = 5.58, SD = .19	M = 6.25, SD = .25
Mutual Trust	M = 6.00, SD = .33	M = 6.25, SD = .25
Mutual Performance Monitoring	M = 5.33, SD = .64	M = 6.10, SD = .35
Perceived Team Effectiveness	M = 6.08, SD = .52	M = 6.42, SD = .14

Table 4

Mean scores and distribution on the scales of the Team Effectiveness Questionnaire in the mid-term and final evaluation of Team B.

Results of the Team Collaboration Evaluator show a relatively limited score distribution in all stages, although they are more distributed in stage 2 on 'mutual trust', 'mutual performance monitoring' and 'perceived team effectiveness' (See Figure 8). Scores on 'shared mental models' and 'mutual trust' are relatively high and stable in all stages. Scores on 'mutual performance monitoring' and 'perceived team effectiveness' slightly rise during the four stages. The overall conclusion is that team members agree on the perceived quality of team collaboration in all stages.

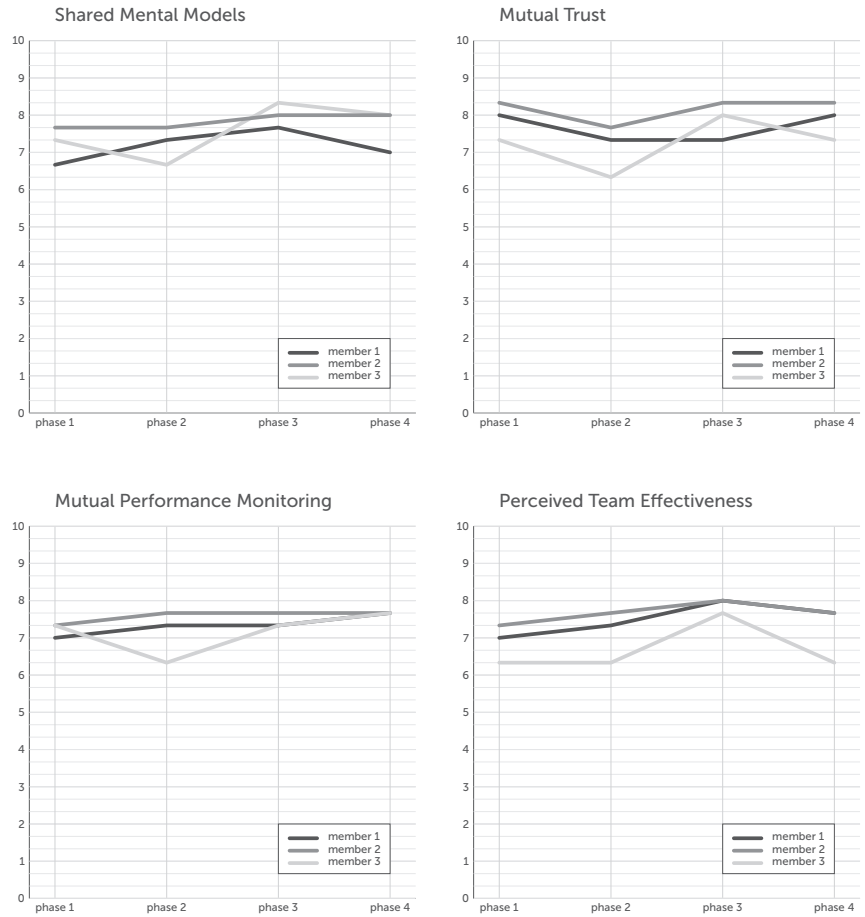

Figure 8

Results of Team B on the Team Collaboration Evaluator in four phases of teamwork.

The Team Interview and the preliminary extra questionnaire confirmed these findings. Team B communicated on a regular basis by meeting face-to-face and via chat, and for every meeting an agenda and minutes were produced:

"We frequently met face-to-face, but also weekly in the chat-area, and once our chat meeting lasted for three hours."

Team B was satisfied with the collaboration, but all team members perceived the assignment as difficult and complex, as was expressed by one member:

"Working collaboratively on this assignment as well as acquiring and processing new knowledge at the same time is complex."

In spite of the consensus found on the Team Collaboration Evaluator and the Team Effectiveness Questionnaire, team members did not agree on the main focus (i.e., process or product), the importance of role division versus workload distribution, and whether leadership was shared within the team. However, all team members saw the team as being task-oriented and perceived the individual qualities of team members as complementary:

"The fact that we produced a concept of the symposium proves that we complement each other as team members. Also, we were focused more on the product than the process."

The result was not innovative, but sound and solid, reflected by the scores and feedback on academic quality of the results. The symposium program was very well prepared and was distributed and advertised punctually. The communication materials were very well designed.

It can be concluded that, based on levels of 'mutual trust' and 'shared mental models' achieved in later stages, team B collaborated harmoniously and in a task-oriented way to deliver results on time. Subtasks were divided, and due to organizing chat-area meetings additional to the face-to-face meetings, final results were delivered in time. Strict procedures for communication compensated for less clear procedures for quality control.

Case 3 – Team C | Team C (three females) explored the needs and conditions for an online 'Community of Practice' for the master program, resulting in design principles and prerequisites for starting such a community. Team formation was based

on the team members' shared interest for this assignment, which they proposed themselves. Team C received a grade of 8.2 for their final product.

Results from the mid-term Team Effectiveness Questionnaire confirm the findings of the Team Collaboration Evaluator. High scores appear on every scale. The final evaluation shows lower scores and increased score distribution on 'mutual performance monitoring' and 'perceived team effectiveness', especially regarding satisfaction with team results and how activities were carried out. Scores are also lower on the items 'being a real team' and 'willing to collaborate with this team in the future'. The mean scores and the distribution on all scales in the mid-term and the final evaluation are presented in Table 5.

Team Effectiveness Questionnaire	Mid-Term Evaluation	Final Evaluation
Shared Mental Models	*M* = 6.58, *SD* = .44	*M* = 6.17, *SD* = .64
Mutual Trust	*M* = 6.75, *SD* = .44	*M* = 6.29, *SD* = .59
Mutual Performance Monitoring	*M* = 6.63, *SD* = .55	*M* = 5.83, *SD* = 1.12
Perceived Team Effectiveness	*M* = 6.67, *SD* = .58	*M* = 5.50, *SD* = 1.32

Table 5
Mean scores and distribution on the scales of the Team Effectiveness Questionnaire in the mid-term and final evaluation of Team C.

Results of the Team Collaboration Evaluator show high scores on all factors throughout the four stages, although scores decrease somewhat in the two later stages (see Figure 9). The scores in stage 1 were very high and hardly distributed, showing a high level of consensus or a genuine team orientation in the beginning. In stage 2, consensus decreases on 'mutual trust', 'mutual performance monitoring', and 'perceived team effectiveness'. In stage 3, consensus also decreases on 'shared mental models'. In stage 4 scores on 'mutual performance monitoring' become more distributed, especially because team members do not agree on the way subtasks are being carried out and the quality of team communication.

The Team Interview and the preliminary questionnaire confirm these findings. Team C communicated regularly in face-to-face meetings, as was expressed by one member:

"We met face-to-face very regularly, but this changed in the later stages to once a week, which was not sufficient for producing a consistent final result."

The chat was perceived as inadequate for team meetings by all members, but email was important, though team members perceived it as less effective or even counterproductive due to an overload of emails in the inboxes as well as team members expecting other team members to be online during weekends to discuss matters. The overload often resulted in miscommunication as mentioned by one member:

"Discussing matters online through email was sometimes difficult and often resulted in misunderstandings."

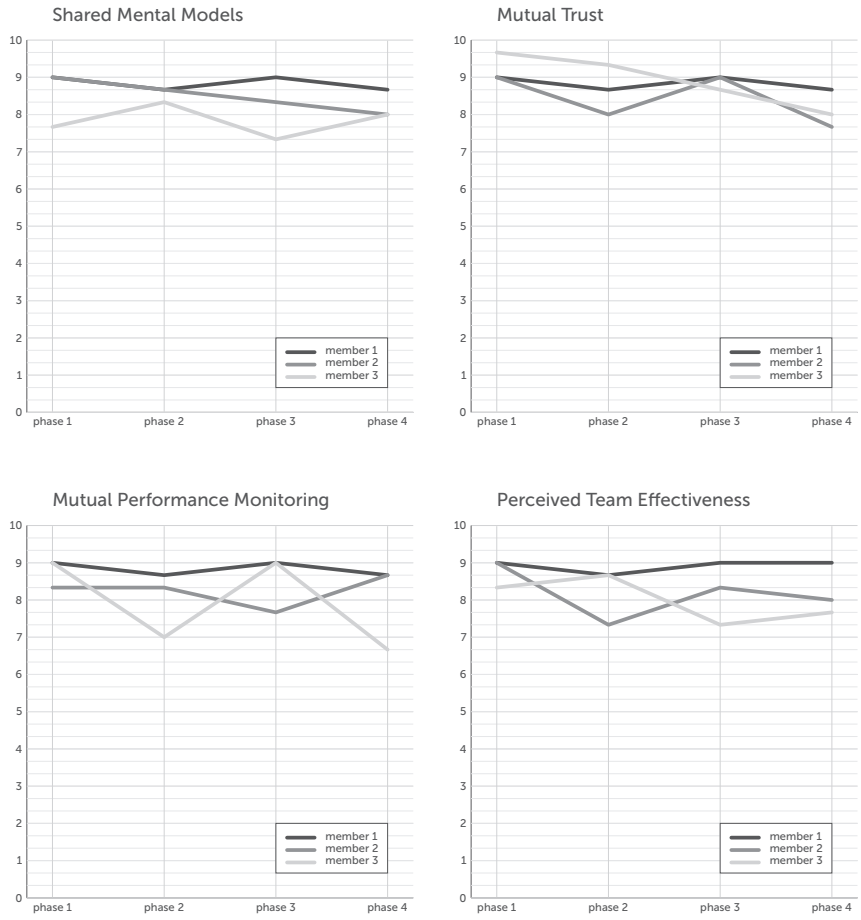

Figure 9

Results of Team C on the Team Collaboration Evaluator in four phases of teamwork.

Team members mentioned that the initial level of mutual trust was very high, but decreased due to conflicts about how to carry out the subtasks, individual accountability, and quality standards for the final product. This miscommunication and lack of trust led to conflicts, and although trust issues were not discussed during the face-to-face group interview session, the situation was described as follows in the questionnaire:

> *"We trusted each other, but one team member tried to force her opinion on us regarding how things should be done. Email communication did not help, we really needed to meet face-to-face to resolve this situation"*

Results of the teamwork were solid, although the quality of the results could have been higher if the team had consulted experts earlier and made better use of expert feedback, which is also reflected by the scores and feedback on academic quality. Nevertheless, the team delivered an advisory report on how to start a Community of Practice.

It can be concluded that high levels of mutual trust were initially present, but decreased during the task due to conflicts and miscommunication. It is possible that initially reported high levels of mutual trust were desired by all members, but not achieved at that time. This got in the way of developing shared mental models on team and task aspects as staying good friends and trying not to hurt feelings seemed to be more important than discussing conflicts. Although team members frequently met face-to-face, used email abundantly, and discussed matters by telephone, they stated that they would have liked more time for sharing and discussing task aspects face-to-face. It seems that team communication was not always effective and open, resulting in spending extra time discussing matters but not discussing difficult issues at all, or not effectively.

Case 4 – Team D | Team D (two females, three males) developed a course on intercultural and cross-cultural competences for students in the Initial Teacher Training program. Team formation was based on the team members' shared interest for this assignment which they proposed themselves. Team D received a grade of 7.0 for their final product.

Results from the Team Effectiveness Questionnaire of the mid-term evaluation confirm the findings of the Team Collaboration Evaluator, revealing low scores and high distribution of the scores on all scales, especially on perceived team effectiveness. In the final evaluation the scores on 'shared mental models' are slightly higher and less distributed, but still relatively low. The scores on perceived team effectiveness are also slightly higher and relatively less distributed, reflecting slightly more consensus within the team on the quality of the final product delivered in the end. Mean scores and the distribution of the scores in the mid-term evaluation and the final evaluation on all scales are presented in Table 6.

Team Effectiveness Questionnaire	Mid-Term Evaluation	Final Evaluation
Shared Mental Models	*M* = 5.00, *SD* = .81	*M* = 5.15, *SD* = .60
Mutual Trust	*M* = 5.10, *SD* = 1.05	*M* = 5.18, *SD* = 1.07
Mutual Performance Monitoring	*M* = 5.46, *SD* = .90	*M* = 4.96, *SD* = .78
Perceived Team Effectiveness	*M* = 4.80, *SD* = 1.59	*M* = 5.10, *SD* = .76

The Team Collaboration Evaluator shows relatively low scores on every factor and high distribution in these scores with scores gradually decreasing during teamwork (see Figure 5). The scores in stage 4 were low and distributed on 'mutual performance monitoring' and 'perceived team effectiveness', reflecting minimal consensus within the team on these aspects. Scores on 'shared mental models' in stage 1 also show a lack of consensus with scores rising in stages 3 and 4, but returning to lower values in stage 4. In stage 4, team members strongly disagree on almost every item of 'mutual trust', 'mutual performance monitoring' and 'perceived team effectiveness' (see Figure 10).

The Team Interview and the preliminary extra questionnaire confirm these findings. Team members perceived the assignment as complex but also as appropriate for collaborative learning, as expressed by a member:

"The complexity of the subject is challenging and the diversity of the team could have resulted in a multidimensional result, which makes this project very suitable for collaborative learning in a master program."

They also perceived the team as being task-oriented, but in spite of the fact that attitudes toward team and task converged, a few team members fell short in delivering results:

"Team members probably did not differ in intentions, but they differed in delivering the individual results."

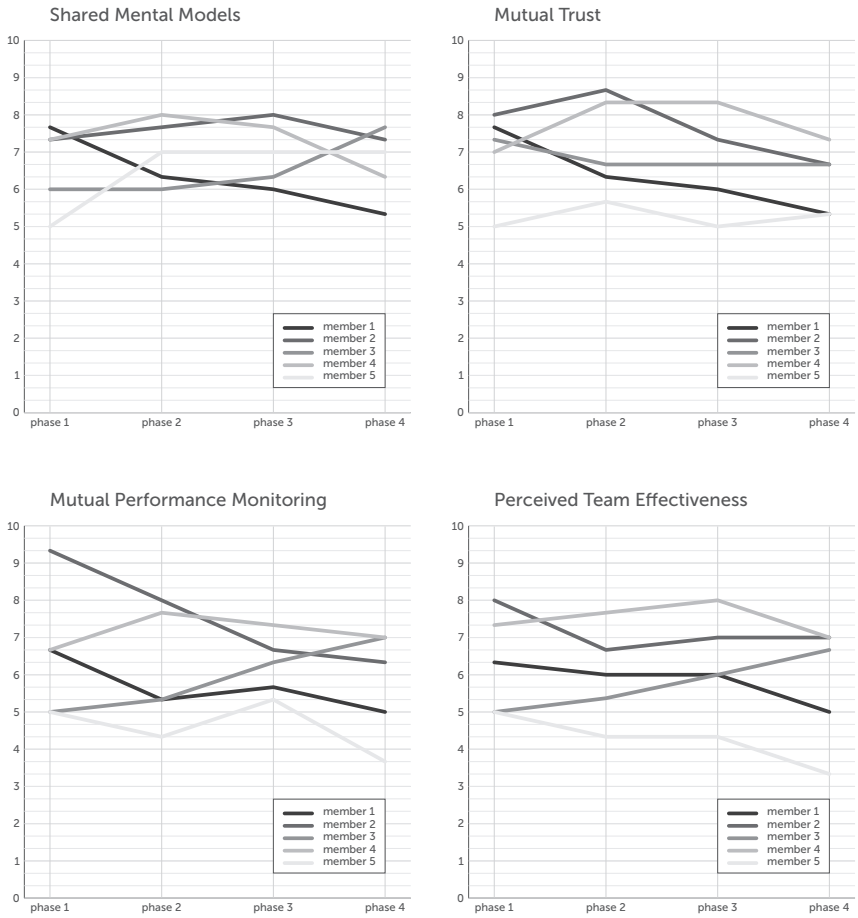

Figure 10

Results of Team D on the Team Collaboration Evaluator in four phases of teamwork.

The answers to questions regarding 'mutual trust' confirm that subtasks were not carried out as agreed by everyone and results were not delivered on time or were not delivered at all. It was probably a difficult problem to solve, in spite of the fact that there seemed to be no conflicts and that the discussions during team meetings were highly valued. Noteworthy is that answers on questions on leadership differed and only two team members perceived leadership in the team as being shared among all members. Conflicts arose on how tasks had to be carried out:

> *"Offering task-oriented feedback was normal in our team, but the feedback was not always processed as it should have been."*

The final product was interesting, but it was not well structured and incomplete and initial intentions were not fulfilled, reflecting the lack of consensus with respect to the final results that should have been delivered.

It can be concluded that the distribution of individual competences was high within this team, which could have been an advantage but did not prove to be so. Although shared mental models on task and team aspects were developed according to team members, it is likely that these models were limited and focused on task aspects. Awareness of team aspects was limited and conflicts that arose were not discussed and solved. In later stages of teamwork, autocratic leadership emerged without consensus on the leadership, but this too was not discussed. Team members perceived team communication, mutual performance monitoring, and the quality of results very differently and as insufficient. A lack of mutual trust resulted in not discussing conflicts, which reinforced the team to become even more pragmatic and task-oriented with respect to delivering final results in time.

Cross-case analysis

Findings of the case studies show that the four learning-teams are different in a number of ways, including team composition, type of assignment and task approach, which may influence their specific development. These differences and their effects on teamwork, team development and team effectiveness are explored in the cross-case analysis. The

results are analyzed with respect to aspects of team development, especially development of task and team related skills as presented in the conceptual framework (Figure 6).

Members of team A were satisfied with the quality of shared mental models and levels of mutual trust, but their satisfaction decreased during the process and perceptions became more distributed. The team members were less satisfied about mutual performance monitoring and perceived team effectiveness, and scores also became more distributed over time. Subtasks were allocated in a very early stage and due to ineffective communication strategies, conflicts arose and errors were made. Team A started energetically, but underestimated task-complexity and developed incomplete mental models on goals and strategies. Strategies for mutual performance monitoring and communication were not well thought through and the team did not adapt its strategies during the process:

> *"Some team members do not acknowledge the importance of preliminary results we have to deliver."*

Task-related skills were not well developed, implying that orientation to the task was superficial, and that the team started developing solutions and dividing subtasks too quickly. Also, goal and strategy adjustment did not take place during the transition phase. Team-related skills were only partly developed since team members did not invest in testing interdependence and developing role-relatedness. Each team member claimed a subtask in an early stage. Role refinement in the transition phase as a response to emerging conflicts and ineffective team communication did not take place. Team A focused on both task and team, as well as on process and results from the start, but switched in an early stage to task and results only. Additionally, team A expended a great deal of energy due to ineffective mutual performance monitoring.

Members of team B were satisfied with all aspects of team collaboration and became even more satisfied during the process. At the same time, they perceived their individual subtasks differently and there is some uncertainty about willingness to support each other in carrying out individual subtasks. Team B developed sufficient initial levels of mutual trust and gradually also shared men-

tal models on goals and strategies. Additionally, mutual performance monitoring was well organized and team communication was effective:

> *"Team collaboration has taken a favorable turn, and although we did not structure this deliberately, it has not resulted in problems or conflicts so far"*

In the transition phase, shared mental models were adjusted and team roles were refined, implying that task- and team-related skills merged to some extent, resulting in increased team effectiveness. Team B focused on both task and team aspects, as well as on process and results, and kept this focus during the whole process. Final results were sound, but could probably have been more innovative if the competences were more distributed.

Members of team C were very satisfied with the overall collaboration at the onset, but gradually became less satisfied. It is likely that unresolved conflicts led to decreased mutual trust and less effective mutual performance monitoring, enhanced by ineffective communication:

> *"The fact that we often had to meet online and discuss matters through email did not work well and resulted in misunderstandings and a lot of irrelevant emails. My strategy now is not responding to emails at all or only replying that we have to discuss the issue in the next face-to-face meeting."*

Team C developed shared mental models on team and task aspects to a certain extent, but these models were less elaborated than team members thought they were. The initial orientation on the team and the task was not as solid as needed, the shared mental models were not adjusted during the transition phase and team roles were not refined. Team C focused mainly on team and process and less on task and results. Also, team communication took a lot of time and was not effective due to conflicts not being discussed adequately and solved properly.

Members of team D were not satisfied with the overall collaboration from the start and this decreased further during the process. The transition phase shows emergence of autocratic leadership aimed at managing the teamwork

from that moment on. This could not prevent the final results being incomplete because some team members did not deliver individual results as agreed:

> *"The deadline for delivering results is approaching and the group implicitly decided to act pragmatically, which implies that we keep on working to deliver a final version."*

The quality of the shared mental models was limited in team D, especially regarding team aspects, and team D did not develop these models in time. Mutual trust was low at the onset and did not increase. Although the team oriented to the task for a long period of time, it did not lead to developing clear goals and strategies, or solutions. Due to the quality of shared mental models, low levels of mutual trust, and ineffective team communication, mutual performance monitoring was ineffective and team effectiveness was low. Team-related skills were not developed since interdependence was not tested and intra-group conflicts were not discussed and solved. As a result, role-relatedness could not be developed. In the transition phase, the team could not adjust goals and strategies and refine roles within the team, leaving the team with no other option than acting pragmatically. Team coordination was claimed by one team member without discussion and this was taken for granted by the rest. Team D focused only on task and results with this focus becoming more extreme as a result of conflicts not being discussed and resolved.

The cross-case analysis shows that developing both task-related and team-related skills seems conditional for learning-team effectiveness. Both skills have to be developed in parallel during teamwork and must be combined if a team is to become productive. Learning-teams that focus too much on either team skills or task skills may experience difficulties in becoming effective, especially if goals and/or strategies are not adapted during the transition phase. The cross-case analysis also shows that teams probably have to develop shared mental models on both team and task aspects before the transition phase, because the quality of shared mental models seems to be conditional for effectively adapting goals and/or strategies in the transition phase to become productive and effective.

Conclusions and discussion

Four case studies and a cross-case analysis were carried out to explore the importance of the key variables mediating learning-team effectiveness in the different stages of teamwork. These case studies and the cross-case analysis seem to confirm the importance of team and task awareness for learning-teams to become effective (Fransen et al., 2011). Both a task-related and team-related shared mental model probably must be developed in early stages of teamwork and a sufficient level of initial mutual trust seems to be conditional for developing the shared mental models. Learning-teams probably also have to balance their focus between team aspects and task aspects to develop both team-related skills and task-related skills, and have to combine these skills to become productive and effective as a team. Task-related skills imply a sound orientation to the task and an open exchange of ideas and opinions to establish team goals and strategies and to develop solutions. Team-related skills imply some sort of initial conflict and testing of interdependence, as well as development of group cohesion and role-relatedness to effectively define roles within the team (Morgan et al., 2001). A limited imbalance in skills development may be repaired in the transition phase, but probably only if shared mental models and sufficient mutual trust are already present. Only then can a team adapt its strategies and refine the roles to become effective and successful in a final productive phase (Gersick, 1988). Teams that focus on both the team and the task tend to become effective in an earlier stage and adapting goals and/or strategies as well as refining roles in the transition phase will probably not be necessary. Such teams require only small adjustments to become even more goal-oriented (Williams et al., 2006).

This study has its limitations. First, only four learning-teams participated and conclusions may not be generalized. The teams also differed on team size, male-female ratio, distribution of expertise, as well as other individual characteristics of the team members. This research has to be replicated in various learning practices in the context of higher education to confirm the findings and also to further explore and explain the relations between of these variables and the development of learning-teams towards effectiveness. Also, on the basis of replication on a larger

scale it might be possible to validate the Team Collaboration Evaluator and develop this instrument towards a 'Team Tester' to characterize learning-teams in an early stage of teamwork, to monitor team development, and to possibly predict team effectiveness.

This study showed the importance of developing task-related and team-related skills for developing task-related and team-related shared mental models; a requirement for operating as an effective learning-team. Additionally, sufficient levels of trust must be present in early stages of teamwork since this initial trust is probably conditional for developing a task-related and team-related shared mental model as a team, effectively monitoring the process, and adequately handling task conflicts and relational conflicts within the team. If mutual trust is low and task complexity is high, task conflicts are difficult to solve, especially if the team also experiences relational conflicts, and the joint effect of both type of conflicts will likely be detrimental for team effectiveness (De Dreu & Weingart, 2003). Learning-teams in the context of higher education are assumed to be capable of doing this without any help or support, which is remarkable since learning-teams are confronted with challenging tasks from which they also are supposed to learn, while at the same time not having access to the resources to do so. In addition, they must behave as an effective team almost from the start seeing the length of most projects. This study showed that becoming effective as a learning-team is not something that 'just happens', even for university students who already have experienced collaborating in teams in organizational settings. It seems to confirm that team skills are highly team and task-specific and can only partly be transferred when the team members are assigned to a new team with a new task (Prichard, Bizo, & Stratford, 2006). Student learning-teams need support in the early stages of teamwork to become fully aware of the importance of developing task-related and team-related skills to be effective as a team. Only then will the added value of collaborative learning be experienced by students in higher education.

CHAPTER 5

Team Effectiveness in Collaborative Learning: Explaining Learning-Team Maturation[4]

4 This chapter is based on: Fransen, J., Erkens, G., & Kirschner, P. (submitted). Team effectiveness in collaborative learning: Team maturation and team effectiveness.

The quality of collaborative learning depends on the quality of the team collaboration and therefore on student learning-team effectiveness. This chapter aims at explaining relations between team activities and team maturation. Using a validated learning-team effectiveness framework, four case studies and a cross-case analysis explored the relations between team characteristics, team development, and the framework's variables which were found to mediate team effectiveness. All meetings of the learning-teams were recorded – for analysis – during a full semester and the teams were interviewed afterwards. Results show that for a learning-team to become effective, it probably is important that team members focus on both team aspects and task aspects in early stages of teamwork, as well as balance between a focus on process and outcomes during the whole process. It seems that teams must develop both a task-related and a team-related mental model early in the collaboration to adequately monitor team performance and collaboration and adapt their strategies and performance in a transition phase which occurs when the deadline for delivering results approaches. The analysis also shows that learning-teams can be characterized by the way they balance these variables during the teamwork process.

Introduction

Expectations of higher education are rising and learning collaboratively in communities of inquiry to facilitate knowledge construction is considered an important pedagogical approach (Garrison & Anderson, 2003; Garrison & Cleveland-Innes, 2005). Ideally, learning-teams collaborate to carry out a complex open assignment in which interdependency has been built in so as to facilitate and stimulate knowledge construction and conceptual change (Bereiter & Scardamalia, 1996; Blumenfeld et al., 1996; Harden & Davis, 1998). However, even when these prerequisites have been fulfilled, effective learning-team performance is not guaranteed and the quality of learning outcomes is sub-optimal. The primary cause of this 'failure' is that team members do not collaborate effectively. Learning-team effectiveness is expressed by the quality of team outcomes, the quality of team performance, and perceived fulfillment of individual team members' needs (Hackman, 1990).

A validated conceptual framework (Fransen et al., 2011) consisting of variables that influence learning-team effectiveness from a team development perspective revealed that teams must develop shared mental models if they are to be effective. Within this developmental perspective, developing both task-related and team-related skills in initial stages of team collaboration has been found to be conditional for learning-teams to become effective (Fransen, Kirschner, & Erkens, submitted). To function optimally, learning-teams need to find a balance between their focus on task-related skills (e.g., orientation to the task, open exchange, producing solutions, completion of the task and delivering results) and team-related skills (e.g., testing interdependence, developing group cohesion, refining of roles, fulfillment of roles and adjustment to environmental demands) as this allows them to adequately monitor their teamwork and effectively adapt to changing circumstances during a transition phase (i.e., the phase in which a team becomes acutely aware that the deadline for a specific product is imminent). In this transition phase, teams will often change their task strategies and/or teamwork procedures to increase their productivity so as to the approaching deadline. The approach chosen can vary from adapting goals and/or strategies and re-dividing roles and/or subtasks to simply speeding up performance

by intensifying mutual performance monitoring through providing feedback on preliminary results en reviewing team members' contributions. However, the exact nature of balancing the task-related and team-related skills with respect to team characteristics and team development has not been established. Exploring how learning-teams develop task-related and team-related skills (i.e., how a team matures) offers insight into (1) what learning-teams focus on in the different stages of teamwork, (2) the relations between learning-team characteristics and how a team balances task and team-related skills (including their focus on outcome and process) in order to become effective. To this end, four case studies were carried out along with a cross-case analysis to compare teams on their maturation as a learning-team during teamwork.

Conceptual framework

The studies in this article are based on a conceptual framework (Fransen et al., 2011; Fransen et al., accepted) consisting of three factors that influence team effectiveness (i.e., mutual performance monitoring, back-up behavior, and adaptability), and three mechanisms that support and help coordinate this (i.e., shared mental models, mutual trust, and closed-loop communication). The factors and mechanisms, both considered variables mediating learning-team effectiveness, are briefly presented here. For a full discussion of how the framework was developed and validated the reader is referred to chapter 2 and chapter 3.

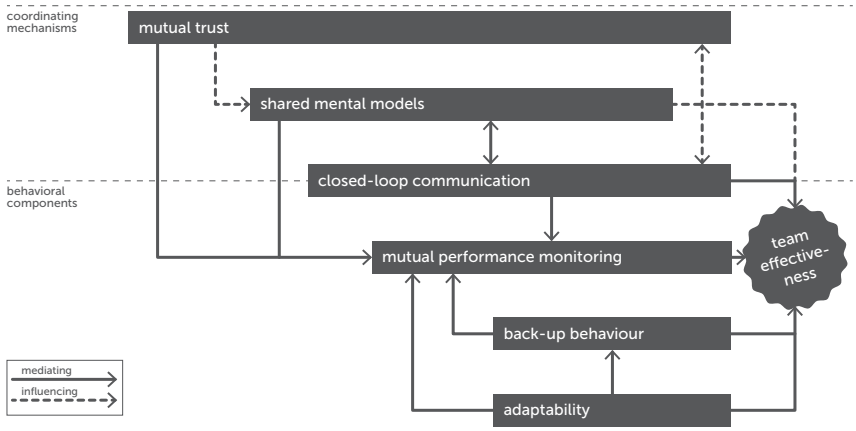

Figure 11

Conceptual framework with variables mediating learning-team effectiveness.

Supporting and coordinating mechanisms | A *shared mental model* is conditional for setting team goals, deciding on strategies, allocating subtasks to team members, adequately monitoring team processes, and effectively communicating (Klimoski & Mohammed, 1994; Salas et al., 2005; Van den Bossche, 2006). Developing a shared mental model (i.e., shared goals and strategies) is very important for learning-teams that are expected to carry out project-based or problem-based assignments, since they also have to deliver collaborative products. A shared mental model is positively related to team effectiveness, with knowledge content being predictive of team performance but not of the team process, and knowledge structure being predictive of both team performance and team process (DeChurch & Mesmer-Magnus, 2010). It seems to confirm findings suggesting that mental model accuracy (i.e., the knowledge content accurately representing the task demands) is related to a team's belief about goal accomplishment, and mental model similarity (i.e., the team members understanding the task demands in a similar way) is related to a team's belief of team viability and experiencing working together as positive (Resick, Dickson, Mitchelson, Allison, & Clark, 2010).

Mutual trust implies a shared perception that every team member will perform particular actions important to the team and its members, and will protect the rights and interests of fellow team members (Salas et al., 2005). Findings suggest that the effect of mutual trust on learning-team effectiveness is limited, because such teams usually operate in a pragmatic way where only minimal levels of cognition-based trust (McAllister, 1995) are conditional for developing shared mental models (Fransen, et al., 2011). Also, trust emerging in early stages of teamwork allows the development of interpersonal ties among group members and reduces the likelihood of task and relationship conflicts in later stages (Curşeu & Schruijer, 2010). This initial trust should not be based on friendship, since this may lead to fault-lines within a team (Molleman, 2005), and since social identity congruence does not necessary lead to or may inhibit the development of knowledge-related identity congruence in a team (Hughes, 2009).

Communication (i.e., information exchange between a sender and a receiver, irrespective of the medium) facil-

itates updating a team's shared mental model (Salas et al., 2005). When the complexity of a situation increases, closed-loop communication is conditional (i.e., the sender initiates a message, the receiver ackowledges its receipt, and the sender verifies both receiving the receipt-message and understanding its content and meaning; P. Kirschner et al., 2008).

Factors in team effectiveness | *Mutual performance monitoring* implies keeping track of fellow team members' work while carrying out one's own work to ensure that all is running as expected and procedures are followed correctly (Salas et al., 2005). Based on the expected behavior and monitoring the actual behavior of others a team applies a coordination strategy which will differ according to the team members' expectations of team longevity and task difficulty (Baumann & Bonner, 2011).

Back-up behavior is the result of anticipating other team members' needs through accurate knowledge of their responsibilities and shifting the workload among team members to achieve a balance during periods of high workload or pressure. Back-up behavior is related to shared mental models and mutual performance monitoring (Salas et al., 2005).

Adaptability is the ability of a person or group to adjust strategies through back up behavior and reallocation of the intra-team resources, or by altering a course of action or team repertoire in response to changing internal and external conditions based on information gathered from the environment (Salas, et al., 2005).

Team effectiveness | *Team effectiveness*, the dependent variable in the framework, includes the quality of the team's performance as well as the perceived satisfaction of team members' needs. The influence of the variables mediating team effectiveness will probably differ according to the phase of the teamwork. For example, without achieving a shared mental model in an early stage of the process, it is unlikely that a learning-team will become productive and effective. On the other hand, back-up behavior and adaptability will probably be more important in later phases when conditions in the team and/or in the environment may change and goals and/or strategies have to be reconsidered to meet a deadline. The variables mediating team effectiveness along with the phases of teamwork are presented in Figure 12.

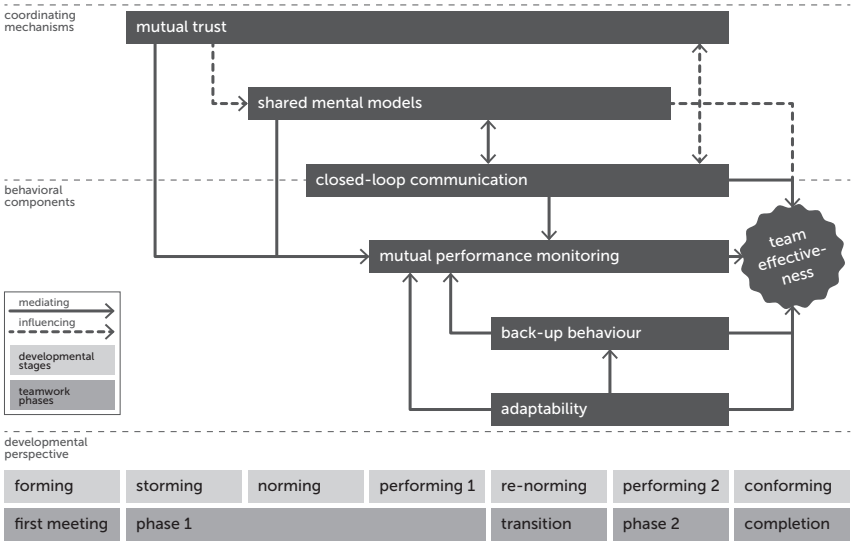

Figure 12

Framework with variables influencing or mediating learning-team effectiveness positioned within the perspective of learning-team development.

Ad-hoc learning-teams are often initially ineffective because they cannot effectively imagine the final results, and because they have insufficient information about the distribution of expertise / competences within the team. Learning-teams, therefore, have to develop to become effective as a learning-team and variables mediating team effectiveness must be seen within a perspective of team maturation. The perspective used here was derived from the "Team Evolution And Maturation model" or TEAM model (Morgan et al., 2001), which is an attempt to combine existing models into one team-development model, including Tuckman's stages model (Tuckman & Jensen, 1977) which suggests that teams develop progressively by passing through stages, and Gersick's (Gersick, 1988) punctuated equilibrium model which suggests that team development may be rapid and abrupt due to approaching deadlines for result delivery and task-related problems that have to be solved. The TEAM model also describes a set of developmental stages, but teams do not have to proceed through all these stages and may start at different stages, according to past experiences of the team and its members. Deadlines and the task at hand influence team development and learning-teams usually experience a transition phase (i.e., a re-norming stage) when a deadline approaches. Teams that did not perform well now adapt their performance in order to deliver results on time, teams that performed well often adapt their performance

towards a more practical and goal-oriented performance. Essentials of the TEAM model as a developmental perspective for learning-teams are presented in Figure 13.

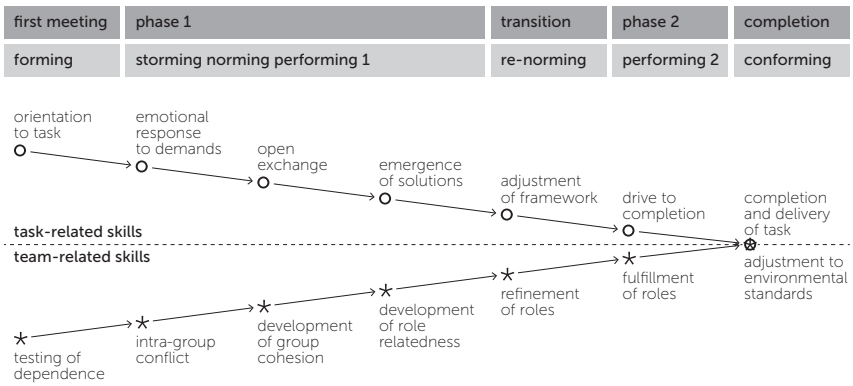

Figure 13

Essentials of the TEAM model with teamwork phases, team development stages, and convergence of task-related skills and team-related skills during team maturation (adapted from Morgan et al., 2001, *Journal of General Psychology*, 120(3), p.281).

The core aspects of this conceptual framework were tested to establish its value for future experiments on influencing learning-team effectiveness (Fransen et al., 2011). Findings showed the importance of team and task awareness for team effectiveness, as well as a tendency of teams collaboratively learning in higher education to be pragmatic by focusing primarily on task aspects and less on team aspects. Learning-teams, like work-teams, have to develop team-related and task-related mental models in early stages of collaboration to become productive and deliver final results (Fransen et al., 2011). However, the noted pragmatism may result in learning-teams focusing too strongly on task aspects and not enough on team aspects. Such pragmatism may also result in focusing too much on delivering final results, especially when the deadline approaches, and too little on adequately monitoring team collaboration and task execution processes so that all members contribute and learn. To further explore the importance of the variables mediating team effectiveness, and to establish if a learning-team can be characterized by how it approaches task and team issues during all phases of teamwork, four case studies and a cross-case analysis were carried out. Team meetings during a semester of teamwork were recorded and analyzed, followed by a cross-case analysis to explore and explain similarities and differences between teams with respect to teamwork characteristics and their influence on

team effectiveness. This study focuses on the following research question: How do task-related and team-related activities with regard to developing shared mental models and monitoring team performance contribute to the emergence of learning-team effectiveness?

Method

Participants in the four case studies, the instrumentation, procedures and data analysis are being reported here.

Participants | Students (N = 15; 8 males/7 females, mean age = 39.6, SD = 5.6) from a learning & innovation master program at a large university in the Netherlands worked in teams on assignments in their final study year as part of a required course. They received no remuneration – financial or otherwise – for their participation. Students had a say in team formation, since the teams were composed on the basis of shared interest in a subject and/or assignment. While 3 assignment topics were offered, students could also propose an assignment themselves. The assignments took one full semester to complete (20 weeks). The teams communicated face-to-face and online, and team spaces were offered within the university's virtual learning environment to facilitate the exchange of work-in-progress, peer review, and publication of results. Each team was offered its own chat-area and forum, exclusively accessible to them. Students were divided over 4 teams of 3 to 5 members; teams had not worked in this composition before. The students were informed about the research project and all agreed to take part.

Instrumentation | Data were used from recordings of team communication during face-to-face team meetings which were transcribed for analysis and all teams were interviewed after completing the assignment.

Team communication | All teams had regular face-to-face meetings (i.e., on average every two weeks) to discuss the task and the process of teamwork. The teams were provided with recording devices to record their meetings and these recordings were analyzed by the researchers. Since only one team used their chat-area on a regular basis, chat-logs were not included in the analysis. Team members discussed task and team issues by telephone, email, and face-to-face apart from scheduled team meetings, but since it usually concerned bilateral communication between individuals, it was not considered to be team communication.

Team interview | Teams were interviewed after delivering their results (i.e., at the end of the semester). Team members were asked to complete an online questionnaire with 40 questions on four topics (i.e., task characteristics, task approach, team trust, and quality assurance) a week prior to the interview. The questionnaire was used to explore individual opinions on conditions for effective team collaboration and the extent to which these conditions were met in the assignment they had just completed. By first employing the questionnaire, the interview could be limited to 1-hour for each team. The interview was carried out with the help of an electronic support system (ZING Technologies; http://www.anyzing.com/). Each team member has a keyboard to answer questions and all answers are projected on a screen for a group discussion. The ZING strategy guarantees equal participation of all team members during the team interview and produces a full transcript of the interview. The responses were analyzed to explore patterns in responses of the members of each team. The team-interview protocol can be found in Appendix E.

Procedure | All teams recorded their face-to-face meetings in the institute using a voice recorder provided by the researcher. One member of each team was responsible for the recordings. The voice recorders were returned to the researcher after completion of the assignment. Students were informed about the research before the start of the semester and permission was requested for recording and analyzing the face-to-face team meetings for research purposes.

The questionnaire for the team interview was presented three days prior to the interview, which was held after the team results were presented. Response rate was 100%. Students were informed about the privacy of the data and that responding would not influence their grades. One student missed the interview due to personal reasons not related to the research. Students were given a small present after completing the team interview as a token of appreciation for their commitment, though this was not known to them prior to the study. Two researchers were present at each team interview.

Data analysis | Elaborated minutes were made from the recordings by two research assistants, noting what was said and/or decided by the team during each minute of a meeting. A coding scheme was developed based on the conceptual frame-

work on variables mediating team effectiveness with eight codes covering task aspects or team aspects from the perspective of orientation to either the process or outcomes of teamwork. The codes refer to activities and/or statements oriented towards the:

- *task and results* contributing to a task-related shared mental model on goals and strategy (TaRsGoals; TaRsStrategy).
- *team and results* contributing to a team-related shared mental model on the distribution of expertise within the team, as well as role division as a result of that (TeRsSkills; TeRsRoles).
- *task and process regulation* contributing to effective task-related mutual performance monitoring through process management and review of results (TaRgContent; TaRgTaskFb).
- *team and process regulation* contributing to team-related mutual performance monitoring through discussing team collaboration and reviewing team members' contributions to team collaboration (TeRgSocial; TeRgTeamFb).

The pairs of codes can be combined into codes on the first level covering task-related and team related aspects of either 'shared mental models' (SMM Task and SMM Team) or 'mutual performance monitoring' (MPM Task and MPM Team). The complete coding scheme with descriptions is presented in Table 7.

Coding was executed using MEPA 4.10 (Multiple Episode Protocol Analysis), developed by one of the authors (Erkens, 2005). One code was assigned to team communication during each minute of the meeting, provided that what was discussed and/or decided by a team was related to one subject or topic. If more than one subject or topic was under discussion during the timeframe of one minute, the record was split and one code was assigned to both new records. Two researchers independently coded all items in the communication reports of one team (i.e., about 20% of all communication reports) and agreed on coding for 81.6% (Cohen's kappa = .77). The number of entries on each code within every team meeting is reported in summary tables and higher scores are visualized by darker shading of the cells. The number of entries on the first-level codes (i.e.,

summing up the entries of two second-order codes) into task-related and team-related shared mental models and mutual performance monitoring are reported in the same overall table, also with darker shading of cells with higher scores. Total numbers of entries per meeting and per code are also reported. Data from the preliminary questionnaire and team interview were used for triangulation purposes, more specifically to confirm and explain findings of the coded communication reports.

Table 7
Coding scheme for analyzing learning-team communication during team meetings.

Code	Description	Aspects
TaRsGoals	Team interaction about goals and final results of teamwork, including the intermediate results and deliverables of teamwork.	Discussion/decision about the goals of the assignment or project.
		Discussion/decision about final results to deliver.
		Discussion/decision about deliverables and intermediate results to deliver.
		Discussion/decision about conditions to meet in order to deliver results.
TaRsStrategy	Team interaction about task execution strategies leading to delivering the intermediate and the final team results, including all conditions that have to be met.	Discussion/decision about the different work packages to distinguish.
		Discussion/decision about all subtasks that have to be carried out.
		Discussion/decision about sequencing work packages and subtasks.
		Discussion/decision about procedures that must be implemented.
TeRsSkills	Team interaction about the distribution of skills within the team and the competences of all team members.	Discussion/decision about expertise of team members.
		Discussion/decision about individual competences of team members.
		Discussion/decision about expertise not available within the team.
TeRsRoles	Team interaction about the allocation of subtasks among team members and/or role division within the team.	Discussion/decision on preferences of members for subtasks and roles.
		Discussion/decision about allocation of subtasks/workload within the team.
		Discussion/decision about functional roles and positions within the team.

Code	Description	Aspects
TaRgContent	Team interaction about task execution, process management and solving task problems that arise, including all the quality assurance activities.	Discussion/decision about progress in task execution and problems that must be solved.
		Discussion/decision about managing the process and quality of results.
		Discussion/decision about planning the process, including team meetings.
		Discussion/decision about what media to use in team communication and for quality assurance.
TaRgTaskFb	Team interaction aimed at the improvement of the task execution by asking feedback of others and/or providing a team member with task-related feedback on the individual subtask execution.	Feedback on results team members delivered, including team members reporting on subtask execution.
		Advising and/or supporting a team member in subtask execution.
		Debate or conflict about the quality of subtask execution and/or results.
TeRgSocial	Team interaction to reflect on the team collaboration, including the contributions to the team collaboration of all team members.	Discussion about the contributions of a team member to the team
		Discussion about contributions of team members to team collaboration.
		Discussing or reflecting on the quality of team collaboration.
		Discussion about how team members communicate and media preferences of team members.
TeRgTeamFb	Team interaction aimed asking for or providing feedback on the self about contributions to the team and the task, including interaction about conflicts in the team.	Feedback on the self, regarding task execution, like compliments/critique.
		Feedback on the self, regarding how a member contributes to the team.
		Discussing conflict between members or tensions within the team.

Results

The findings of the four case studies are reported first, followed by the cross-case analysis.

Case 1 – Team A | Team A (2 males, 2 females), collaborated to organize a field trip for the master program including a visit to an international conference. The team had to determine the trip's program and organization (i.e., travel, hotel and transport during the trip). Team formation was based on the team members' shared interest for this assignment.

Team A had 11 face-to-face meetings ranging from 25 minutes to 1 hour and 40 minutes. The team discussed the

goals of teamwork early in the process and resumed this discussion very briefly before delivering results (See Table 8 for the summary of Team A). They discussed strategies extensively during the whole process, especially after meeting 3. The team also discussed task execution during each meeting. Team A hardly discussed team members' skills and only discussed role division within the team in early stages. The discussion on role division is being resumed in meeting 8 and 9, possibly related to the fact that discussions on strategies intensify also during these meetings. Team members do not spend much time providing each other with feedback on subtask execution, apart from meetings 4 and 5. It is possible, however, that feedback on subtasks was not provided during face-to-face team meetings but via email or otherwise, since miscommunication and/or not exchanging results of subtasks before team meetings may have led to not having anything to discuss during face-to-face meetings. They also did not discuss team collaboration and they only discussed team collaboration briefly in early stages of teamwork and during meeting 8, probably as a result of discussions on strategies are also more intense in meeting 8.

Not having developed a task-related shared mental model in time as a team, especially a shared mental model on strategies, probably explains why the team spent more time regulating the process due to misunderstandings and/or team members not delivering their results. The team briefly discussed a team-related mental model in an early stage and team-related performance monitoring was only apparent in meeting 8, which may stand for roles being divided as well as subtasks allocated right from the start, which was not debated or adapted until meeting 8. Team collaboration is being discussed during meeting 8, which may be explained by procedures being discussed and adapted at the same time. Team A definitely is task oriented, but apparently not very effective in task execution as a result of not having developed an elaborate task-related shared mental model (i.e., goals and strategies) in an early stage of teamwork and inadequate monitoring of task execution as a result of that. Figure 14 shows the team evolution based on the number of entries on each code, representing the time spent on developing task-related and team-related mental models as well as task-related and team-related mutual performance monitoring during all meetings.

Table 8
Summary Table of Team A.

	Meeting 1	Meeting 2	Meeting 3	Meeting 4	Meeting 5	Meeting 6	Meeting 7	Meeting 8	Meeting 9	Meeting 10	Meeting 11	Total per code
TaRsGoals	17	29	6	9	12	2	0	0	1	5	0	**81**
TaRsStrategy	27	19	17	40	35	33	10	33	33	30	10	**287**
TaRsSkills	1	13	4	3	3	1	2	2	0	1	0	**30**
TaRsRoles	12	18	2	15	9	6	1	5	7	1	2	**78**
TaRgContent	14	14	12	18	19	15	9	9	19	7	11	**147**
TaRgTaskFb	0	1	7	17	23	2	4	8	6	7	3	**78**
TaRgSocial	5	6	1	6	3	3	0	7	2	0	0	**33**
TaRgTeamFb	0	0	0	3	3	2	0	5	3	6	2	**24**
OffTask	2	0	4	2	4	0	7	1	0	0	1	**21**
Total per meeting	**78**	**100**	**53**	**113**	**111**	**64**	**33**	**70**	**71**	**57**	**29**	
SMM-Task	44	48	23	49	47	35	10	33	34	35	10	**368**
SMM-Team	13	31	6	18	12	7	3	7	7	2	2	**108**
MPM-Task	14	15	19	35	42	17	13	17	25	14	14	**225**
MPM-Team	5	6	1	9	6	5	0	12	5	6	2	**57**

TaRsGoals	team interaction on goals and final outcomes	SMM-Task	task-related shared mental model
TaRsStrategy	team interaction on task execution strategies		
TeRsSkills	team interaction on distribution of expertise	SMM-Team	team-related shared mental model
TeRsRoles	team interaction on task allocation and roles		
TaRgContent	team interaction on process of task execution	MPM-Task	task-related mutual performance monitoring
TaRgTaskFb	team interaction on a member's performance		
TeRgSocial	team interaction about the team collaboration	MPM-Team	team-related mutual performance monitoring
TeRgTeamFb	team interaction on a member's commitment		

The team confirmed the results from the analysis of the team communication during the team interview and emphasized the fact that subtasks were allocated during the first meeting. The team seemed satisfied with the developed task-related mental models in the beginning, but they nevertheless encountered problems with information exchange, which revealed the fact that goals and strategies, as well as procedures for quality assurance were not thoroughly discussed and agreed upon. A few team members also perceived the team-related shared mental model as insufficient, which in their opinion lead to differences in team commitment:

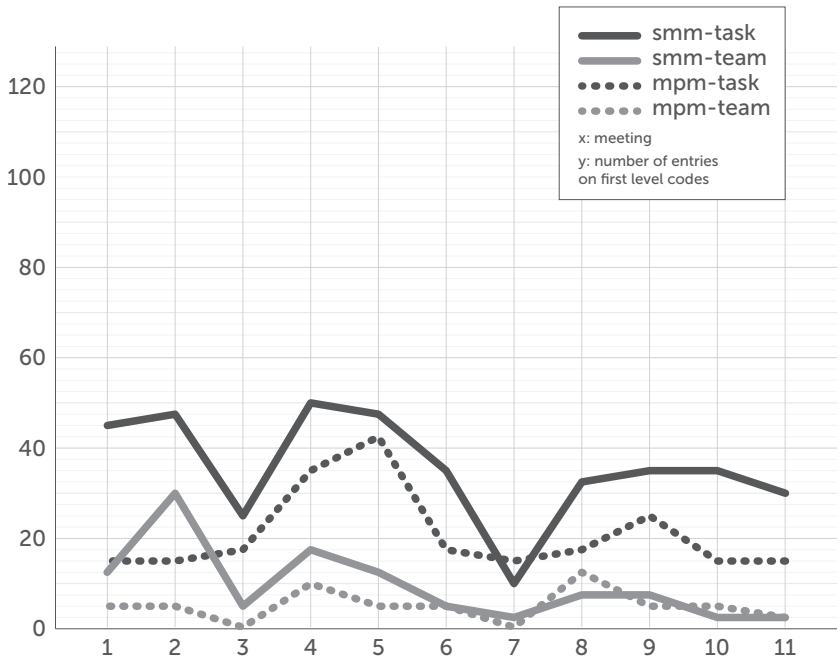

Figure 14

Development of team communication of Team A based on time investment in discussing task-related and team-related shared mental models and mutual performance monitoring.

> *"It became clear to me that I was more ambitious than the other team members regarding parts of the task. They wanted to do less and only after discussion they were willing to put in a bit more effort."*

Ineffective communication and not having discussed and decided on adequate procedures for quality assurance resulted in errors being made, minor conflicts and misunderstandings:

> *"Team members also incompletely discussed task aspects outside team meetings without telling others or documenting the outcomes, which resulted in things being forgotten."*

As a result of that, the team intensified discussions on strategies in meeting 8, but not on goals. These discussions lasted until the final meeting and probably did not result in adaptations in strategies and process monitoring, and/or in subtask re-allocation, while providing each other with feedback on subtask execution remained limited also.

Case 2 – Team B | Team B consists of three members, all male, collaborating on organizing a symposium for the master program, with respect to content (i.e., planning a relevant program and inviting a key-note speaker), and organization (i.e., location, enrollment and catering). Team formation was based on team members' shared interest for this assignment.

Team B had 7 face-to-face meetings during the semester of teamwork with time spans ranging from 35 minutes to 2 hour and 15 minutes. Team B also met 6 times in the chat-area, but these meetings were not included in the analysis. The team elaborately discussed team goals in the first meeting, but gradually less during meetings 2 to 7, which might imply that consensus on what exactly had to be delivered was established in an early stage of teamwork (see Table 9).

Discussions on strategies gradually take more time during meetings 3, 4 and 5, which might be explained by the fact that either no consensus was reached on task execution in an early stage, or the nature of the task forced the team to constantly adapt their strategy as a result of changing environmental demands (i.e., issues and constraints related to organizing a symposium). This also would explain that task regulation is being elaborately discussed also during these meetings. Team members provide each other with task-related feedback during all meetings, but especially during meeting 4 and before delivering final results. Skills and role division within the team were only discussed during meetings 1 to 3, which probably means that consensus on role division and subtask allocation was established in an early stage of teamwork.

The combined scores show that time spent on developing a task-related shared mental model decreases from meeting 1 to 7, while time spent on task regulation increases (See Figure 5). Given the assignment (i.e., organizing a symposium) and the dynamics of teamwork, a shift in focus from developing a task-related shared mental model to task regulation is understandable and even desirable. Team B also developed a team-related mental model in an early stage, which might indicate that the team was quite satisfied with the results and had no reason to adapt this model in later stages. Team B only discussed team collaboration during meeting 2 and therefore team B can be characterized as task-oriented.

Team members confirmed during the interview that their team was task-oriented and they perceived team collaboration as satisfactory:

> *"We produced a concept program for the symposium and the fact that we did that as a team proves that the team members' competences are complimentary."*

Table 9
Summary Table of Team B.

	Meeting 1	Meeting 2	Meeting 3	Meeting 4	Meeting 5	Meeting 6	Meeting 7	Total per code
TaRsGoals	94	11	25	20	13	2	1	**166**
TaRsStrategy	19	11	37	49	39	23	26	**204**
TaRsSkills	15	11	5	1	1	0	0	**33**
TaRsRoles	3	10	28	4	5	6	4	**60**
TaRgContent	6	20	16	23	23	10	26	**124**
TaRgTaskFb	4	8	12	29	13	18	14	**98**
TaRgSocial	2	18	5	2	3	5	4	**39**
TaRgTeamFb	0	3	2	0	3	0	2	**10**
OffTask	5	1	7	6	2	0	5	**26**
Total per meeting	**148**	**93**	**137**	**134**	**102**	**64**	**82**	
SMM-Task	113	22	62	69	52	25	27	**370**
SMM-Team	18	21	33	5	6	6	4	**93**
MPM-Task	10	28	28	52	36	28	40	**222**
MPM-Team	2	21	7	2	6	5	6	**49**

TaRsGoals	team interaction on goals and final outcomes	SMM-Task	task-related shared mental model
TaRsStrategy	team interaction on task execution strategies		
TeRsSkills	team interaction on distribution of expertise	SMM-Team	team-related shared mental model
TeRsRoles	team interaction on task allocation and roles		
TaRgContent	team interaction on process of task execution	MPM-Task	task-related mutual performance monitoring
TaRgTaskFb	team interaction on a member's performance		
TeRgSocial	team interaction about the team collaboration	MPM-Team	team-related mutual performance monitoring
TeRgTeamFb	team interaction on a member's commitment		

Team members confirmed that they agreed on strict procedures for team meetings and project management, but perceived the assignment as challenging:

> *"After two meetings and exchanging ideas, I experience that we did not yet start with the assignment. We reached consensus on goals and strategies only after tutor intervention."*

They also perceived their subtasks differently and there was some uncertainty at some point about the willingness to support each other in carrying out these subtasks.

Case 3 – team C | Team C consisted of three members, all female, collaborating during a semester on exploring the needs and conditions for a 'Community of Practice' for the master program, resulting in design principles and prerequisites for starting such a Community of Practice. Team formation was based on team members' shared interest for this assignment, which they proposed themselves.

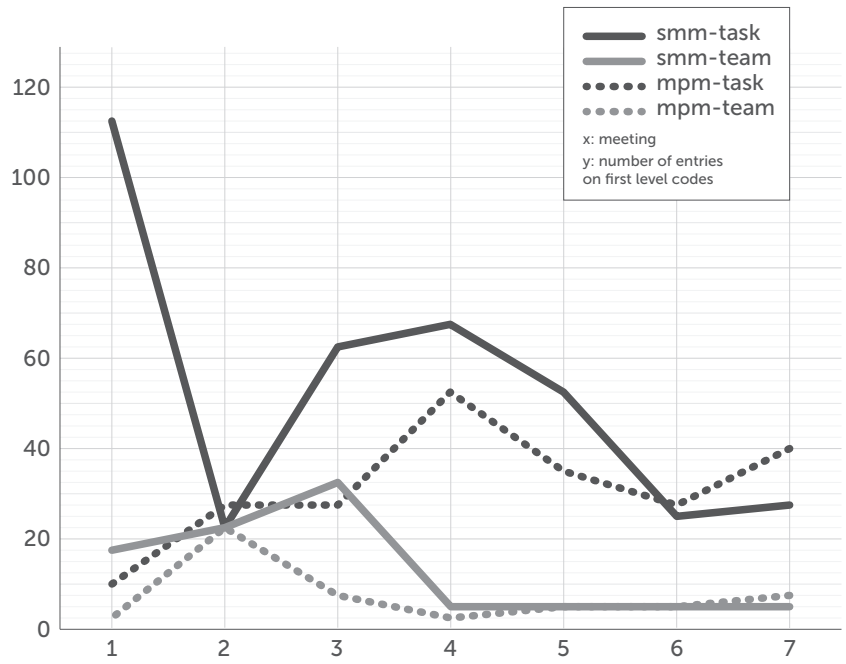

Figure 15

Development of team communication of Team B based on time investment in discussing task-related and team-related shared mental models and mutual performance monitoring.

Team C had 9 face-to-face meetings during the semester of teamwork with time spans ranging from 30 minutes to 2 hours and 10 minutes. The team elaborately discussed team goals during meetings 1 to 4, and discussed strategies during almost every meeting. Task execution is being discussed also during meetings 1 to 5 and in the last meeting before delivering results. The team members provided each other with task-related feedback during almost all meetings, with a peak in the meetings 7 to 9, probably related to the approaching deadline and intermediate results being produced by everyone. Elaborately discussing task execution in meeting 1 is remarkable, but may be related to elaborately discussing team collaboration in that meeting also, possibly aimed at testing dependence (i.e., norming) and allocating subtasks. However, role division is being discussed during meeting 2 and 3, and also in later stages of teamwork. In later stages the team also discussed the quality of team collaboration, which is probably related to discussing role re-division and subtask re-allocation at the same time (See Table 10). Team members elaborately discussed each-other's contribution to the team in de final meeting, which might be explained that conflicts aroused that needed to be solved and/or team collaboration had to be evaluated by the team in this final meeting.

Team C not only invested in developing a task-related shared mental model, but also in developing a team-related shared mental model in early stages of teamwork, but the fact that the discussions on these mental models are re-opened to some extent in the final meeting, as well as discussions on role division and everyone's contributions to the team, may indicate that there were some conflicts to solve. Also, starting from meeting 7 discussions on strategies are being re-opened there is an increase in time spent on providing each other with task-related feedback, which suggests that strategies, role division and subtask allocation are being adapted during this stage of teamwork due to the team not being satisfied with team collaboration and team results so far (See Figure 16).
During the interview team members confirmed that they were satisfied with the quality of team collaboration at the onset, but that conflicts arose in later stages due to ineffective team communication:

"The fact that we often had to meet online and discuss matters through email did not work well and resulted in misunderstandings and a lot of irrelevant emails. My strategy now is not responding to emails at all or only replying that we have to discuss the issue in the next face-to-face meeting."

Table 10

Summary Table of Team C.

	Meeting 1	Meeting 2	Meeting 3	Meeting 4	Meeting 5	Meeting 6	Meeting 7	Meeting 8	Meeting 9	Total per code
TaRsGoals	16	49	56	40	1	0	6	0	0	**168**
TaRsStrategy	0	31	39	46	50	6	39	16	66	**293**
TaRsSkills	2	15	3	6	13	0	1	0	0	**40**
TaRsRoles	3	24	27	10	15	9	17	12	24	**141**
TaRgContent	41	28	24	21	30	8	6	9	21	**188**
TaRgTaskFb	4	19	25	38	28	9	40	30	40	**233**
TaRgSocial	23	31	20	3	10	2	2	4	16	**111**
TaRgTeamFb	0	3	3	0	4	3	14	2	23	**52**
OffTask	3	10	3	1	6	0	3	1	3	**30**
Total per meeting	**92**	**210**	**200**	**165**	**157**	**37**	**128**	**74**	**193**	
SMM-Task	16	80	95	86	51	6	45	16	66	**461**
SMM-Team	5	39	30	16	28	9	18	12	24	**181**
MPM-Task	45	47	49	59	58	17	46	39	61	**421**
MPM-Team	23	34	23	3	14	5	16	6	39	**163**

TaRsGoals	team interaction on goals and final outcomes	SMM-Task	task-related shared mental model
TaRsStrategy	team interaction on task execution strategies		
TeRsSkills	team interaction on distribution of expertise	SMM-Team	team-related shared mental model
TeRsRoles	team interaction on task allocation and roles		
TaRgContent	team interaction on process of task execution	MPM-Task	task-related mutual performance monitoring
TaRgTaskFb	team interaction on a member's performance		
TeRgSocial	team interaction about the team collaboration	MPM-Team	team-related mutual performance monitoring
TeRgTeamFb	team interaction on a member's commitment		

Although team C developed a task-related shared mental model, a team-related mental model probably was not elaborately discussed and developed since conflicts arose and the team had to adapt teamwork by focusing more on strategy and providing each other with task-related feedback.

Case 4 – Team D | Team D consists of five members, two female and three male, collaborating during a semester on the development of a course on inter-cultural and cross-cultural competences for students of the Initial Teacher Training program. Team formation was based on team members' shared interest for this assignment, which they proposed themselves. Team D had 8 face-to-face meetings during the semester of teamwork with time spans ranging from 35 minutes to 1 hour and 35 minutes. Team D elaborately discussed goals and strategies during early stages of teamwork, especially during meeting 1 and 2 (See Table 11). The team briefly discussed skills and role division during early stages which indicates that only limited information about team members' competences was exchanged on which decisions on role division and subtask allocation should be based.

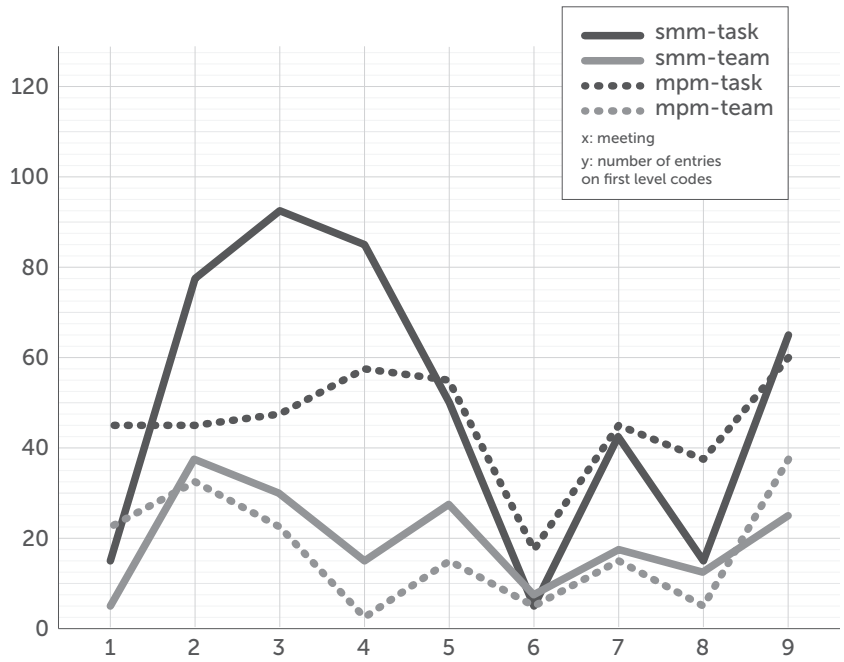

Figure 16

Development of team communication of Team C based on time investment in discussing task-related and team-related shared mental models and mutual performance monitoring.

Team members provided each other with task-related feedback in meetings 3 to 5 and in the final stages of teamwork. Team collaboration changes after meeting 5 mirrored by the abrupt ending of the discussion on goals, re-opening a discussion on strategies and role-division, and an increase in time spent on providing each other with task-related feedback. Also, since time spent on monitoring task execution only increases slightly in meeting 7, all symptoms

Table 11

Summary Table of Team D.

	Meeting 1	Meeting 2	Meeting 3	Meeting 4	Meeting 5	Meeting 6	Meeting 7	Meeting 8	Total per code
TaRsGoals	63	93	54	43	30	0	7	5	**295**
TaRsStrategy	15	22	33	38	15	4	21	7	**155**
TaRsSkills	11	6	8	14	8	0	1	1	**49**
TaRsRoles	4	9	12	8	2	6	18	17	**76**
TaRgContent	10	16	13	2	7	7	17	6	**78**
TaRgTaskFb	0	2	39	19	16	1	45	15	**137**
TaRgSocial	7	4	4	5	2	1	10	4	**37**
TaRgTeamFb	0	0	0	2	0	0	2	0	**4**
OffTask	2	2	1	1	7	0	2	5	**20**
Total per meeting	**112**	**154**	**164**	**132**	**87**	**19**	**123**	**60**	
SMM-Task	78	115	87	81	45	4	28	12	**450**
SMM-Team	15	15	20	22	10	6	19	18	**125**
MPM-Task	10	18	52	21	23	8	62	21	**215**
MPM-Team	7	4	4	7	2	1	12	4	**41**

TaRsGoals	team interaction on goals and final outcomes	SMM-Task	task-related shared mental model
TaRsStrategy	team interaction on task execution strategies		
TeRsSkills	team interaction on distribution of expertise	SMM-Team	team-related shared mental model
TeRsRoles	team interaction on task allocation and roles		
TaRgContent	team interaction on process of task execution	MPM-Task	task-related mutual performance monitoring
TaRgTaskFb	team interaction on a member's performance		
TeRgSocial	team interaction about the team collaboration	MPM-Team	team-related mutual performance monitoring
TeRgTeamFb	team interaction on a member's commitment		

may indicate that one member claimed leadership resulting in a radical change by putting discussions to an end and deciding on adapting teamwork by re-dividing roles and/or reallocating subtasks, combined with intensifying feedback procedures within the team, which also may imply that team members had to account for what they already delivered or not. During meeting 7 team collaboration is briefly discussed, which was hardly done in previous meetings.Team D can definitely be characterized as very task-oriented, but obviously failed in developing a task-related shared mental model on time. Team D seemed to fail completely in developing a team-related shared mental model, which also explains why mutual performance monitoring was almost exclusively task-oriented (See Figure 17).

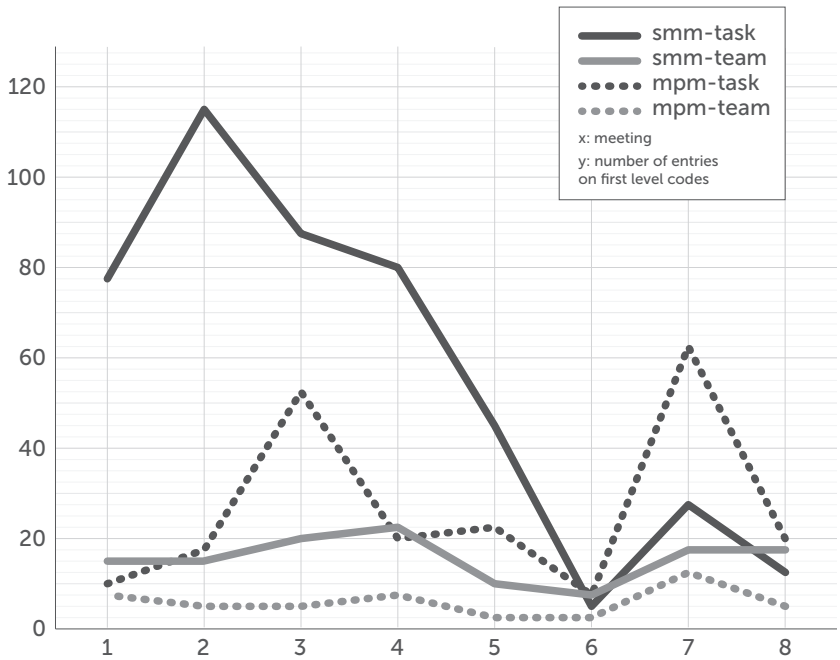

Figure 17

Development of team communication of Team D based on time investment in discussing task-related and team-related shared mental models and mutual performance monitoring.

Team members confirmed in the interview that they perceived the team as task-oriented, but that some members were not satisfied with the quality of teamwork and team collaboration. In that perspective they also mentioned not having developed a team-related mental model:

"Team members probably differ too much with respect to expertise and expectations, as well as in approaching the task to make this project successful. That is why I am not convinced of the added value of collaborative learning."

Team members also confirmed not having developed a task-related mental model and were aware of the problems the team encountered as a result of that:

"We as a team are still trying to reach consensus about the conditions to be met with the product we like to deliver."

Team members perceived leadership within the team differently, and only one member perceived leadership within the team as being shared among all team members.

Cross-case analysis

Combining the results from the analysis of team communication and findings of the team interviews shows that all teams are primarily task-oriented (i.e., a focus on a task-related shared mental model and task-related mutual performance monitoring), which in itself is not surprising given the usually pragmatic attitude of student learning-teams in higher education (Fransen et al., 2011). However, teams differ with regard to the characteristics of their task-orientation and how they balance this with an orientation on team aspects in different stages of teamwork.

Team A focused limited on reaching consensus on goals, but invested gradually more time in discussing strategies, although they did not seem to develop a task-related mental model during the process of teamwork. They increasingly invested in task-related mutual performance monitoring, but with a focus on task management and not on reviewing results. They developed a team-related shared mental model only in an early stage of teamwork, and team-related mutual performance monitoring only got minimal attention during meeting 8, which seems to mark a transition phase. Given the fact that a task-related mental model was not well developed well, the team was doomed to primarily focus on process management without being very successful and the review process during team meetings was

not very effective due to not delivering subtask results on time and/or miscommunication within the team. The transition phase, therefore, probably did not result in adaptation and consolidation of a task-related shared mental model since discussions on strategies were not concluded, but in investing more time in process management without being able to purposively discuss improvement of results based on a task-related shared mental model. Also, team A probably did not develop an elaborate team-related shared mental model as rationale for subtask re-allocation during a transition phase. Team A can be characterized as task-oriented, but mainly focusing on process and less on product.

Team B started with focusing on goals, but the focus gradually shifted to strategies which were being discussed throughout the process of teamwork. They probably also developed a team-related shared mental model in an early stage of teamwork. Team B increasingly invested in task-related mutual performance monitoring with a focus on process management, although reviewing results also became important in later stages. Although team members kept investing in developing a shared mental model on strategies, they apparently developed a task-related shared mental model on goals, but less on strategies. Process management was facilitated by the team's procedures regarding team communication, decision making and planning, which may imply that the team could focus more on reviewing results in the final stages. The pattern of team development of team B does not show a clear transition phase with a substantial change of teamwork, only extra time was invested in reviewing subtask results to speed up performance and produce the final results on time. Team B can be characterized as task-oriented, balancing a focus on process and product probably as a result of approaching deadlines.

Team C started with focusing on goals in an early stage of teamwork but apparently reached an agreement on that after four meetings. However, discussions on strategies continued until the final meeting, which may imply that the task-related shared mental model is constantly being updated. Team C developed a team-related shared mental model, but predominantly by discussing role division and subtask allocation. This became even more important during and after meeting 7, which probably marks a transition phase. It might imply that a team-related shared

mental model was not developed well in an early stage and/or conflicts arose. Team C invested in task-related mutual performance monitoring with a shift in focus on process management in earlier stages to reviewing results in later stages which implies that the team could focus on producing final results based on agreements on what to deliver. The team invested in team-related mutual performance monitoring in an early stage of teamwork and after the transition phase, the latter possibly related to conflicts regarding role division and subtask allocation. The transition phase probably marks an update and adaptation of the team-related shared mental model, followed by a shift in focus from the process to delivering results. Team C can be characterized as both task-oriented and team oriented, balancing between a focus on process and product.

Team D heavily invested in developing a task-related shared mental model until meeting 5, which marks a transition phase. They primarily focused on goals and not on strategies, but the discussion on goals ended abruptly during the transition phase. The team D invested some time in developing a team-related shared mental model until the transition phase, but during and after the transition phase discussions were resumed and intensified, exclusively aimed at role division and subtask allocation and not on exchanging information about each other's expertise. The team only invested in monitoring the team process after the transition phase, but focused on reviewing results before and after the transition phase. Task-related mutual performance monitoring seemed to be important throughout the process of teamwork, but especially right after a transition phase, focusing on reviewing results and speeding up performance to deliver final results on time. Team D can be characterized as task-oriented, predominantly focusing on the product.

Conclusion and discussion

Four case studies and a cross-case analysis were carried out to further explore the nature of team maturation in the different stages of teamwork.

All teams experienced a transition phase a few weeks prior to the deadline for delivering final results (Gersick, 1988), confirming previous findings (Fransen, et al., submitted), though the adaptations that the teams implemented

during this phase differed. If a team reaches agreement on goals and strategies in an early stage of teamwork and this task-related shared mental model is updated during the next stages of teamwork, and if a team also reaches agreement on role division and subtask allocation based on shared recognition of team members' skills and competences, the transition phase does not result in drastic adaptations in either strategy, role division, subtask allocation, or process management. In that case, only limited adaptations are needed to speed up performance, resulting in spending more time reviewing intermediate results to deliver final results. It confirms findings which suggest that teams with higher quality of a shared understanding of the task demands will adapt their strategies more efficiently and make decisions more quickly (Resick, Murase, et al., 2010).

If, however, a team does not reach agreement on goals and strategies in an early stage, discussions about a task-related shared mental model will probably be resumed during the transition phase. This is done to determine strategy adaptations, divide roles, allocate subtasks, and decide on procedures for quality assurance and/or process management. Reaching agreement in this case probably only occurs when the team has developed a shared team-related mental model since this is conditional for effectively deciding on role re-division and subtask re-allocation, as well on procedures for quality assurance. Also, the absence of an adequate team-related shared mental model is likely to interfere with communication and might even lead to miscommunication and conflicts due to a lack of awareness of other team members' skills, needs and/or preferences. The absence of a minimal level of trust in an early stage of teamwork may impede the development of a team-related shared mental model because team members may challenge each-others' qualities and views (Curşeu & Schruijer, 2010).

The transition phase may lead to drastic adaptations when task-related as well as team-related mental models have not been developed in an early stage and cannot be developed during the transition phase. Here, time constraints probably force the team to pragmatically adapt teamwork procedures and focus on making the best of what has been produced so far in order to deliver a final result. This drastic adaptation of teamwork in teams that did not

develop both shared mental models before the transition phase will likely be due to the emergence of authoritarian leadership in the team with one member taking control and dictating new teamwork procedures. A team member taking control may be the result of the other team members relying on his/her expertise or this team member being the most extrovert in teams involved in a task with low demonstrability (Bonner & Sillito, 2011).

This study has its limitations. First, only four teams participated and conclusions may therefore not be generalized. The teams also differed in team size, male-female ratio and expertise distribution. This study must therefore be replicated in various learning settings in higher education to confirm the findings. Secondly, team assignments were comparable in size and complexity, but differed in nature and this may have had some influence on the dynamics of teamwork, more specifically on the nature of task-related mental models and task-related mutual performance monitoring.

This study confirmed the importance of teams developing a task-related and team-related shared mental model in an early stage of teamwork as well as the fact that learning-teams are predominantly task-oriented, acting pragmatically due to the fact that they are ad-hoc teams collaborating for a restricted period of time (Fransen et al., 2011). Developing task-related and team-related shared mental models as a learning-team is not always simple and straightforward, not in the least because such teams have to accomplish this in the first weeks of teamwork. This is further complicated by the fact that team members are often not able to envision the possibly elaborate outcomes of the assignment because it is – by definition – a learning assignment for developing expertise through learning collaboratively (Fransen et al., accepted). These caveats may be solved by scripting the collaboration (Frank Fischer & Mandl, 2005) and/or by guidance or tutor interventions during different stages of teamwork on collaborative tasks (Slof, Erkens, Kirschner, Jaspers, & Janssen, 2010).

CHAPTER 6

Team Effectiveness in Collaborative Learning: Team Development, Tutor Interventions and Team Effectiveness[5]

5 This chapter is based on: Fransen, J., Kirschner, P., Erkens, G., & Van den Born, A. (submitted). Collaborative learning in higher education: Team development, tutor interventions, and team effectiveness.

Collaborative learning is an often used pedagogical approach used in universities of applied sciences where problem or project-based learning are aimed at knowledge construction, product development and teamwork skills acquisition. In such cases, team effectiveness is conditional for both team performance and learning quality which in turn requires the learning-team to develop from a group of students into a team. Based on a validated conceptual framework, two case studies and a cross-case analysis were carried out to confirm findings of previous case studies and explore the perceived effects of tutor interventions on team maturation and effectiveness. Data were gathered from questionnaires, a team interview, and team communication. Results confirm the importance of developing both a task-related and team-related shared mental model within the team in an early phase of collaboration to become effective as a team, especially since such models seem to be imperative for adaptation of team and task strategies during a transition phase just prior to product submission (to the teacher) if necessary. In teams where such models are not properly developed, either centralized autocratic leadership is likely to emerge to deal with the critical situation or teams probably expect the tutor to show directive leadership behavior and act as substitute for the missing team leader. Learning-teams probably need tailor-made support by an experienced tutor on both task execution and team collaboration to become effective in an early stage.

Introduction

Collaborative learning is based on a paradigm which holds that students must become involved in a process of knowledge construction through discussion, debate or argumentation if they are to establish deep learning and understanding (Bereiter, 2002; Bruffee, 1993; Geelan, 1997). To achieve this, students need to work with conceptual artifacts in a more or less open or divergent assignment with built-in interdependency (Blumenfeld et al., 1996). In the context of higher education, knowledge construction activities are often intentional effects of problem-based or project-based assignments (Blumenfeld et al., 1996; Harden & Davis, 1998) where team effectiveness is conditional for the quality of the learning outcomes (Salomon & Globerson, 1989). This effectiveness – often defined in terms of the quality of team performance and perceived fulfillment of team member needs (Hackman, 1990) – has been found to be influenced by learning style or cognitive ability of team members (Alfonseca et al., 2006; Webb & Palincsar, 1996), decision-making style and intra-group interaction (Hirokawa et al., 2003), and leadership and/or role assignment in the team (Johnson et al., 2002; Strijbos et al., 2004).

Research on team effectiveness has predominantly focused on long-term work-teams in organizational settings (e.g., companies) where learning is a byproduct rather than a goal of collaborating. The extent to which such research informs aspects of student learning-team effectiveness has been explored by the authors and has resulted in a framework containing variables which mediate learning-team effectiveness within the perspective of learning-team development (Fransen et al., accepted). The validity of core aspects of this framework has been tested, confirming the importance of both team and task awareness for effective learning in teams (Fransen et al., 2011). Additionally, a number of case studies and cross-case analyses have explored the developmental perspective of this framework, and specifically the influence of variables mediating team effectiveness in the different stages of teamwork, along with the relations between team characteristics, team maturation and team effectiveness (Fransen, Erkens, & Kirschner, submitted; Fransen, Kirschner, et al., submitted).

Conceptual framework

Learning-teams differ from work-teams regarding the distribution of power and expertise (i.e., all students have nominally similar limited expertise and organizational status) and the influence on resources and environment (i.e., assignments and scheduling are fixed) (Furst et al., 1999). Also, learning-teams do not have to be extremely efficient since deep learning is often seen as being the result of debate and negotiation (Kapur & Kinzer, 2007). The conceptual framework on learning-team effectiveness (see Figure 18) consists of three factors influencing team effectiveness (i.e., mutual performance monitoring, back-up behavior, adaptability) and three mechanisms coordinating and supporting these factors (i.e., shared mental models, mutual trust, closed-loop communication) (Fransen et al., accepted). For a better understanding, these six elements are briefly described in the following section. For a full discussion of the factors and mechanisms and their interrelationships, the reader is referred to the previously cited articles, presented in chapters 2 and 3.

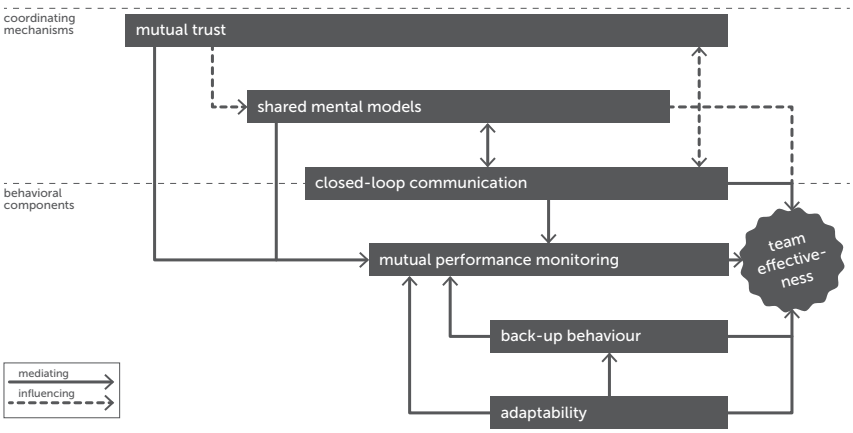

Figure 18
Conceptual Framework with variables influencing or mediating learning-team effectiveness.

Supporting and coordinating mechanisms | *Shared mental models* are conditional for setting team goals, deciding on strategies, allocating subtasks to team members, adequately monitoring team processes, and effectively communicating (Klimoski & Mohammed, 1994; Salas et al., 2005; Van den Bossche, 2006). The development of a task-related shared mental model (i.e., goals and strategies) is important for learning-teams with, for example, project-based

or problem-based assignments, as these teams also have to deliver collaborative products.

Mutual trust implies the shared perception that all team members will perform particular actions important to the team and its members, and will protect the rights and interests of fellow team members (Salas et al., 2005). In learning-teams, the role of mutual trust is limited and differs from the role in work-teams (Olekalns et al., 2007) because in learning-teams only minimal levels of cognition-based trust are needed to develop shared mental models (Fransen et al., 2011). Learning-teams usually collaborate for relatively short periods of time (often maximally one semester) so that continuous assessment of integrity and trusting behavior is of lesser importance for the emergence of learning-team effectiveness.

Communication (i.e., information exchange between a sender and a receiver, irrespective of the medium) facilitates updating a team's shared mental model (Salas et al., 2005), and has to be of a closed-loop character involving the sender initiating the message, the receiver receiving the message and acknowledging its receipt, and the sender verifying that the receipt-message was received and understood (P. Kirschner et al., 2008).

Factors in team effectiveness | *Mutual performance monitoring* implies keeping track of one's fellow team members' work while carrying out one's own work to ensure that all is running as expected and procedures are followed correctly (Salas et al., 2005).

Back-up behavior involves anticipating other team members' needs through accurate knowledge of their responsibilities and shifting the workload among team members to achieve a proper/effective balance during periods of high workload or pressure. It is, therefore, related to shared mental models and mutual performance monitoring (Salas et al., 2005). Back-up behavior may be counterproductive when a team member takes over a subtask of another team member for reasons that are more personal in nature and not related to team goals (Molleman, 2005), or when back-up behavior is a response to 'free-riding' or 'social loafing' and contributing to the final results is left to the more motivated members in the team (Salomon & Globerson, 1989).

Adaptability involves a person's or group's adjusting the strategies through back up behavior and reallocating intra-team resources, or altering a course of action or team repertoire in response to changing internal and external conditions based on information gathered from the environment (Salas et al., 2005). Adaptability usually is not an issue in learning-teams, since external conditions do not change, assignments are fixed and the conditions and deadlines are set by the teacher or institution.

Team effectiveness, as dependent variable in the framework, includes the quality of the team's performance as well as the perceived satisfaction of the team members' needs (Hackman, 1990), the latter being particularly important in learning-teams since interest in a group project will not develop unless individual needs are satisfied (Minnaert, Boekaerts, De Brabander, & Opdenakker, 2011).

Finally, the influence of the mediating variables will probably differ according to the phase of teamwork. Without a sufficient shared mental model in an early stage of the process, it is a team will often not be productive and/or effective. Back-up behavior and adaptability, on the other hand, is more important later in the later phases of teamwork when conditions in the team may change and goals and/or strategies have to be reconsidered in order to meet a deadline.

In the complete conceptual framework (see Figure 19), these elements are seen as variables which mediate learning-team effectiveness within a perspective of team development. The developmental perspective was derived from the "Team Evolution And Maturation model" or TEAM model (Morgan et al., 2001), which combines the essentials of existing models, including Tuckman's *stages model* (Tuckman & Jensen, 1977), and Gersick's *punctuated equilibrium model* (Gersick, 1988), into one team-development model. The TEAM model also describes a set of developmental stages, but teams do not have to proceed through all stages and may start at different stages according to past experiences of the team and its members. Deadlines and the task at hand influence team development and a learning-team usually experiences a transition phase (i.e., a re-norming stage) when the deadline approaches. Teams that were not performing will radically adapt their performance in order to deliver the required results on

time. Teams that had performed well will minimally adapt their performance towards a more practical and goal-oriented performance.

The core aspects of this framework were tested showing the importance of team and task awareness for team effectiveness along with a tendency of learning-teams to be pragmatic and focus more on task aspects of performance and less on team aspects (Fransen et al., 2011). Developing deep trust seems to be less important for learning-teams, but a sufficient level of initial trust is necessary to develop a task-related and team-related shared mental model, which in turn is conditional for a team to become effective.

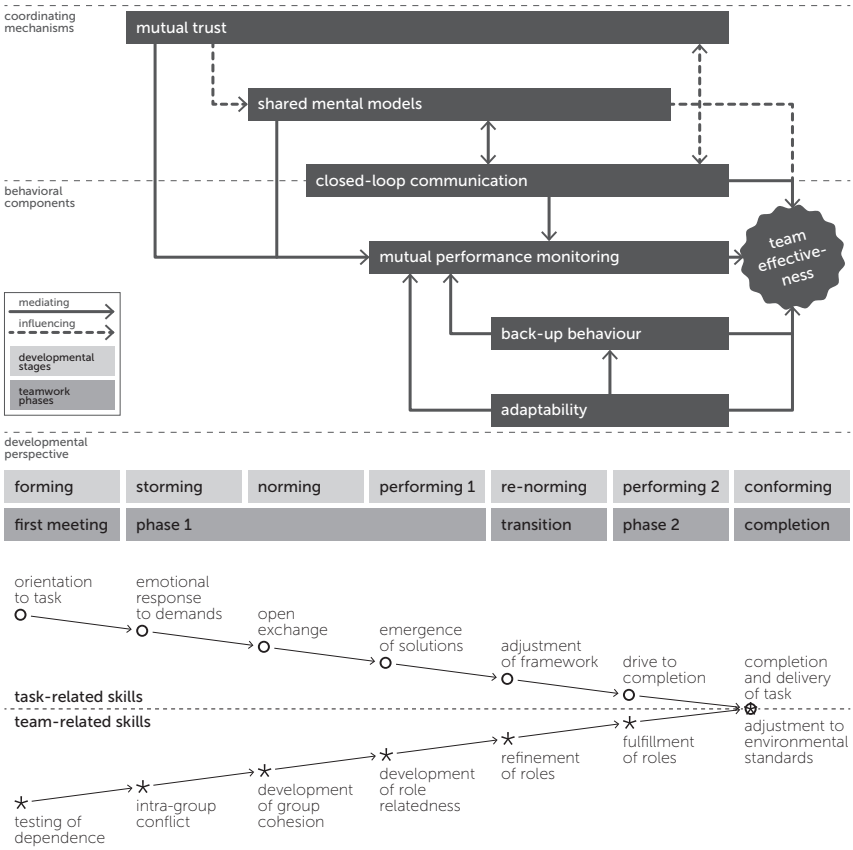

Figure 19

The complete conceptual framework on learning-team effectiveness presenting the variables mediating team effectiveness within the perspective of learning-team development.

Four case studies and a cross-case analysis were carried out, confirming the importance of the key variables in different stages of teamwork and showing how these variables are related to learning-team development, team maturation and team effectiveness (Fransen, Erkens, et al., submitted; Fransen, Kirschner, et al., submitted). To rule out some limitations of these case studies (i.e., content domain, small size) and explore the perceived effects of tutor interventions on learning-team effectiveness, two case studies and a cross-case analysis were carried out in a different content domain to (1) confirm findings of the previous case studies, and (2) explore possible effects of tutor interventions on team development and team effectiveness.

Method

Participants in the four case studies, the instrumentation, procedures and data analysis are being reported here.

Participants | Students (N = 40; 21 males/19 females, mean age = 23.1 years, SD = 5.2) from an International Management and Business Studies Program (IBMS) of a large university worked in teams on a collaborative assignment in their first study year. They received no remuneration for participation and were randomly assigned to the teams by a tutor. The assignment was called 'Dragon's Den', named after the BBC program "in which budding entrepreneurs get three minutes to pitch their business ideas to five multi-millionaires willing to invest their own cash" (bbc.co.uk/programmes/b006vq92). The IBMS teams were required to create and develop a new product and to try to get funding for producing it by defending their business plan before a team of experts. The project involved producing (1) an initial paper, (2) a report on the team's mission statement and role division, (3) a feasibility study, (4) a prototype of the product, and (5) a business plan in one full semester (4 hours/week, 20 weeks). Teams worked mainly face-to-face and intermediate and final results were published in a virtual learning environment for assessment. Students were divided into teams of 4-6 members which had not worked in this composition before. Seven students dropped out of the program due to personal reasons not related to the project. Students were informed about the research and all agreed to take

part. Two teams were selected for the analysis and this selection was based on the fact that all members of a team responded on the questionnaires and were present during the final team interview, and the teams recorded all face-to-face team meetings.

Instrumentation | Three data sources were used to explore and explain investigate the emergence of team effectiveness and the relation with the tutor interventions.

Team Collaboration Evaluator | The Team Collaboration Evaluator (see Appendix C) measured perceived quality of team collaboration in different stages of teamwork. It was derived from the Team Effectiveness Questionnaire (Fransen, Kirschner, et al., submitted) and made use of 12 items from the scales on *shared mental models*, *mutual trust*, *mutual performance monitoring*, and *perceived team effectiveness*. Respondents were asked to rate their team on a scale from 1 to 10 on the 12 items, based on their perception of the quality of team collaboration. Internal consistency based on the data from all questionnaires of all eight learning-teams (N = 40) was good to excellent: shared mental models (Cronbach's α = .84), mutual trust (Cronbach's α = .85), mutual performance monitoring (Cronbach's α = .76), perceived team effectiveness (Cronbach's α = .89). An open question was added asking students to report one incident that they perceived as being important for improving team collaboration.

Team communication | Teams met regularly (i.e., more or less every week) in a face-to-face manner to discuss the task and the process of teamwork. Team meetings were scheduled by the program resulting in similar numbers of meetings for all teams. Teams had supervised meetings attended by a tutor as well as unsupervised meetings. Teams were given voice recorders to record the unsupervised team meetings while tutors recorded the supervised ones. Team members discussed the task and teamwork with each other by telephone, email and informally when they encountered each other, but since it usually concerned bilateral communication between individual team members this was not considered as team communication.

Team interview | All teams were debriefed after task completion via an individual online questionnaire and a group

interview. The online questionnaire consisting of 40 questions on four topics (i.e., task characteristics, task approach, team trust, and mutual performance monitoring) was administered one week prior to the group interview. The questionnaire – based on the interview protocol (see Appendix E) – explored individual opinions on conditions for effective team collaboration and the extent to which these conditions existed in the team. By first administering the questionnaire, the actual interview could be limited to 1-hour for each team. The responses were analyzed to explore patterns in responses of the members of each team and to corroborate these findings with findings of the Team Collaboration Evaluator and the analysis of team communication.

Procedure | The Team Collaboration Evaluator was presented three times online during the semester at intervals of 5-6 weeks, the first time three weeks after starting the assignment and the last time two weeks before the deadline. The questionnaire for the team interview was administered one week before the team interview which was carried out after presentation of team results. The response to the questionnaire was 93.2% after sending personal reminders. Students were assured of their privacy and that responding would not influence their grade. Students received a small present after completing the team interview, though this was not made known prior to the study.

Teams recorded their unsupervised meetings using the voice recorder provided. One member of each team was responsible for this. The voice recorders were given to the researcher after completion of the assignment. Tutors were also provided with voice recorders to record the supervised team meetings. Two tutors were involved, the first for the first six weeks after which she was replaced by a second tutor due to a rescheduling. Tutor interventions were kept – as much as possible – equivalent in both teams, although the support provided differed according the teams' support needs. All participants were informed about the research before the start and their permission was given to record the team meetings for research purposes.

The group interview was carried out by two researchers and the interview was recorded with permission of the students.

Data analysis | Data were analyzed on team level, and since team development was measured by offering the Team Collaboration Evaluator at three different stages of teamwork, patterns in distribution of team-members' perceptions regarding variables mediating team effectiveness were explored. Results of these measurements were compared with findings of the questionnaire and the team interview to confirm these patterns. Pattern characteristics were explained using qualitative data of open questions from all questionnaires.

Elaborated transcriptions of the recordings of the team meetings were made by two research assistants using a worksheet specifically designed for this, marking what was said by the team members during timeframes of one minute of a team meeting, more specifically the topic under discussion and/or the decision made by the team. A coding scheme was used based on the conceptual framework with eight codes covering task and team aspects in the perspective of an orientation on either process or outcomes of teamwork. This scheme was used in a previous study and the codes refer to activities and/or statements oriented towards the:

- *task* and *results* contributing to a task-related shared mental model on goals and strategy (TaRsGoals; TaRsStrategy).
- *team* and *results* contributing to a team-related shared mental model on the distribution of expertise within the team and/or role division as a result of that (TeRsSkills; TeRsRoles).
- *task* and *process regulation* contributing to effective task-related mutual performance monitoring through process management and review of results (TaRgContent; TaRgTaskFb).
- *team* and *process regulation* contributing to team-related mutual performance monitoring through discussing team collaboration and reviewing team members' commitment to the team (TeRgSocial; TeRgTeamFb).

Pairs of codes can be combined into higher-level codes covering task-related and team related aspects of either 'shared mental models' (SMM Task and SMM Team) or 'mutual performance monitoring' (MPM Task and MPM Team). Coding was executed using MEPA 4.10 (Multiple

Episode Protocol Analysis; (Erkens, 2005). One code was assigned during each minute of the meeting, provided that what was discussed and/or decided by a team was related to one subject or topic. If more than one subject or topic was under discussion during the timeframe, the record was split and a code was assigned to each new record. Two researchers independently coded the communication reports of unsupervised meetings of one team (i.e., circa 20% of the communication) and reached 84.4% agreement (Cohen's kappa = .81). The number of entries on each code within every team meeting is reported and higher scores are visualized by darker shading of the cells (see Table 1, 2, 3 and 4). The number of entries on the first-level codes (i.e., summing the entries of two second-order codes) into task-related and team-related shared mental models and mutual performance monitoring are reported in the same table, also with darker shading of cells with higher scores. Total numbers of entries per meeting and per code are also reported.

Tutor interventions during supervised meetings were coded separately by using four codes referring to tutor actions aimed at discussing:

- *project goals* and/or providing feedback or advice on that (TuFbTaRs);
- team *task strategies* and/or providing feedback or advice on that (TuFbTaRg);
- *role division and collaboration strategies* and/or providing feedback or advice on that (TuFbTeRs);
- *team members' contribution to collaboration* and/or providing feedback on that (TuFbTeRg).

Data from the analysis of team communication were used to explain patterns in team maturation and the emergence of team effectiveness along with the perceived effects of tutor interventions on this.

A cross-case analysis was carried out to compare both teams on team maturation patterns and to explore and explain the relations between the mediating variables, team development and team effectiveness.

Results

The findings of two case studies are reported first, presenting the findings of the Team Collaboration Evaluator and the analysis of the team communication during unsupervised and supervised meetings, followed by the cross-case analysis.

Case 1 – Team X | Team X (2 males, 3 females) collaborated on the assignment, though one male left the team in a final stage due to personal reasons not related to the team and/or task. Team formation was decided by the teacher by randomly assigning five students to the team.

Results of the Team Collaboration Evaluator show relatively distributed scores on the four scales, but the scores gradually rise and become less distributed during the next two stages. The scores are especially distributed on the item 'awareness of each-others' competences' of the 'shared mental model' scale, on 'helping each-other' and 'being a team' of the mutual trust scale, and to a lesser extent on the items 'flexibility' and 'communication' of the 'mutual performance' scale, and on the items 'performing as agreed' and 'quality of results' of the 'team effectiveness' scale. However, all scores rise during the next stages and become less distributed and the team apparently is very satisfied about team collaboration and team results. Distributed scores in the first stage are therefore not surprising, since students were randomly assigned to the team and had to test interdependency and positions within the team first and a minimal level of initial trust was not yet established. Figure 20 presents an overview of scores on all items of the Team Collaboration Evaluator in three phases of teamwork.

Team X had 10 unsupervised face-to-face meetings ranging from 30 minutes to 1 hour and 10 minutes, and 9 supervised meetings ranging from 25 to 45 minutes. The analysis of the unsupervised meetings shows that team X discussed the goals of teamwork early in the process, especially during meeting 3, and these discussions were resumed in meeting 6. (See Table 12 for an overview of the number of entries on all codes during all unsupervised team meetings). The team discussed strategies not extensively during the first stage, but gradually more extensively starting from meeting 6, probably enforced by the approaching deadline. Skills and roles within the team were discussed in an early stage potentially due to the Initial Paper assignment, but roles were also discussed

in meetings 4 and 6, and during meeting 6 the discussion on skills was also resumed which may be explained by the refinement of roles in a transition phase. Team X discussed task-management in all meetings, but provided each other with task-related feedback during meetings 6 to 8 as the final deadline approached. Team collaboration was only discussed in an early stage and the team discussed team members' commitment to the team only in meeting 2.

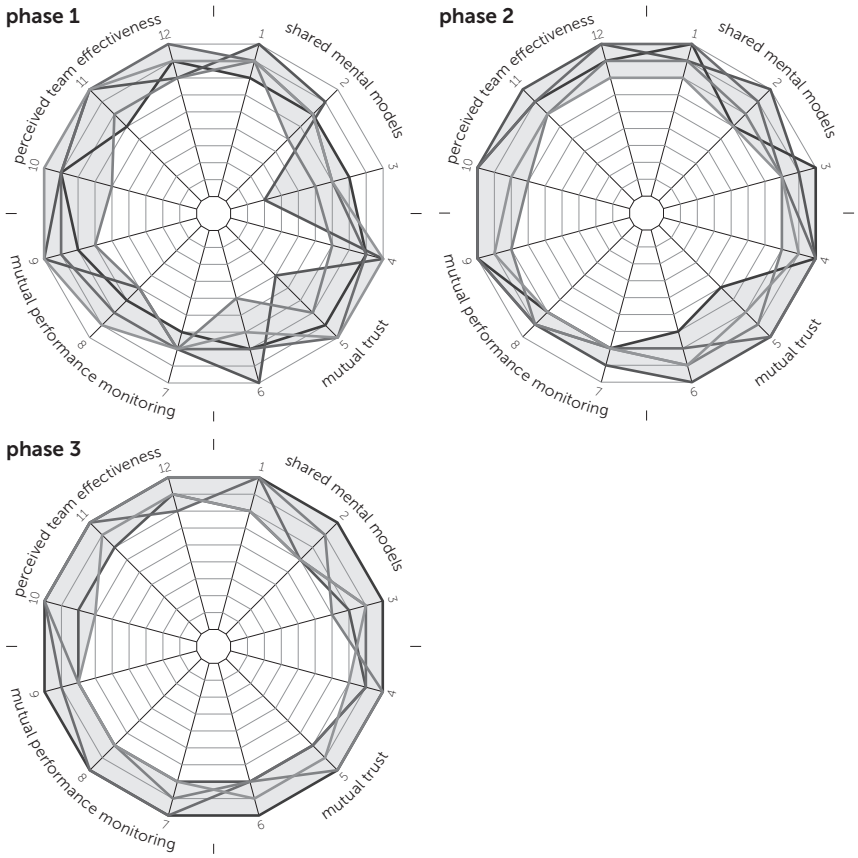

Figure 20

Overview of scores on all items of the Team Collaboration Evaluator in three phases of teamwork of Team X.

The analysis of the supervised meetings shows a similar pattern of time investment in discussing goals, strategies, skills, roles and task management (See table 13). Providing each other with task-related feedback is important in later stages of teamwork, but also during meetings 1 and 2 where students review the initial subtasks (i.e., Initial Paper's sections are being distributed among team

members). Team collaboration is being discussed in meetings 4, 7 and 10, and in meetings 4 and 5 the team discussed team-members' contribution to team collaboration. This coincides in meeting 4 with a substantial increase in tutor interventions, especially with regard to team issues. Team collaboration is being discussed during that meeting and the tutor invites the team to reflect on the quality of team collaboration and on team members' commitment to the team and the task. Meeting 6 seems to mark a transition phase, because discussions on strategies intensify and there is an increase in team members providing each other with feedback on results of subtasks each team member has to carry out. By re-opening discussions on skills and roles during meeting 6, the team probably re-allocated subtasks as a result of one member not delivering results as agreed. In a later stage this team member leaves the team.

Team X can be characterized as task-oriented and also as effective, probably due to having developed task-related and team-related shared mental models in the early stages of teamwork. One team member says:

> *"There was a common goal which was 'reaching the best result possible', meaning that high effort had to be put into the task and not refusing to work. I think that, because everybody put a lot of effort into the project, we as a team must have had this goal."*

Due to one team member leaving the team, the team was forced to adapt its strategies and to re-divide roles and subtasks to speed up performance to meet the deadline for delivering final results. That explains the transition phase team X has gone through, which was not a consequence of not performing effectively before that phase, but of having to solve a problem of one member leaving the team and/or not being able to deliver result. One team member expresses this as follows:

> *"Unity is strength. The team must be willing and motivated to accomplish any task. The group effort makes the task easier and motivates every individual to contribute."*

Table 12

Summary table with all codes in all unsupervised meetings of Team X.

	Meeting 1	Meeting 2	Meeting 3	Meeting 4	Meeting 5	Meeting 6	Meeting 7	Meeting 8	Meeting 9	Meeting 10	Meeting 11	Total per code
TaRsGoals	17	29	6	9	12	2	0	0	1	5	0	**81**
TaRsStrategy	27	19	17	40	35	33	10	33	33	30	10	**287**
TaRsSkills	1	13	4	3	3	1	2	2	0	1	0	**30**
TaRsRoles	12	18	2	15	9	6	1	5	7	1	2	**78**
TaRgContent	14	14	12	18	19	15	9	9	19	7	11	**147**
TaRgTaskFb	0	1	7	17	23	2	4	8	6	7	3	**78**
TaRgSocial	5	6	1	6	3	3	0	7	2	0	0	**33**
TaRgTeamFb	0	0	0	3	3	2	0	5	3	6	2	**24**
OffTask	2	0	4	2	4	0	7	1	0	0	1	**21**
Total per meeting	**78**	**100**	**53**	**113**	**111**	**64**	**33**	**70**	**71**	**57**	**29**	
SMM-Task	44	48	23	49	47	35	10	33	34	35	10	**368**
SMM-Team	13	31	6	18	12	7	3	7	7	2	2	**108**
MPM-Task	14	15	19	35	42	17	13	17	25	14	14	**225**
MPM-Team	5	6	1	9	6	5	0	12	5	6	2	**57**

TaRsGoals	team interaction on goals and final outcomes	SMM-Task	task-related shared mental model
TaRsStrategy	team interaction on task execution strategies		
TeRsSkills	team interaction on distribution of expertise	SMM-Team	team-related shared mental model
TeRsRoles	team interaction on task allocation and roles		
TaRgContent	team interaction on process of task execution	MPM-Task	task-related mutual performance monitoring
TaRgTaskFb	team interaction on a member's performance		
TeRgSocial	team interaction about the team collaboration	MPM-Team	team-related mutual performance monitoring
TeRgTeamFb	team interaction on a member's commitment		

Apparently, the team adequately solved this problem, although the team may have needed the help or support of the tutor to do so effectively. The analysis of the tutor interventions during supervised meetings shows that most interventions were aimed at supporting the team on task management, although the tutor also supported the team in developing a team-related shared mental model and in inviting the team to reflect on team collaboration, but these interventions were specifically carried out during meeting 4 (See table 2). In that meeting discussions with the tutor take up one-third of the meeting.

Apparently, team collaboration was not optimum until that moment, which is reflected by the fact that discussions on skills, roles and contributions of the members to team collaboration also take time in that meeting. It thus, marks the start of a transition phase after which discussions on task strategy, role division and subtask re-allocation become more important, and more feedback is provided on individual performance with one member leaving the team being either the initiation or the result of the transition phase.

The team members confirmed the findings from the Team Collaboration Evaluator and the analysis of team meetings in the team interview in both the preliminary questionnaire and group interview. Team members considered their team as effective, predominantly as a result of effectively communicating, sharing all information within the team, trusting each other from the start, team members being motivated and committed to the team, and the team composition being adequate. Communication was effective in the sense that all team members shared their results of individual subtasks and everyone provided feedback to products of all other team members, and peer-review processes were executed timely. The team predominantly used email for exchanging information and products, which resulted in email overload, but it did not cause problems due to almost everybody delivering his share in time. All information was shared within the team which resulted in everybody being well informed and the shared mental models constantly being updated. Team members defined trust as 'to rely on everyone doing what is agreed upon and delivering expected quality in time', but mentioned that trust also must be developed in the beginning and cannot be expected to be present from the start. They needed some time to establish this within the team and problems with one team member had to be experienced and solved also. One team member did not expect that team members would be trustworthy due to negative experiences with teamwork in previous assignments. She said:

> *"I was prepared for the worst, like team members not doing their part as expected, but when I experienced that almost everyone was doing his task, I was reassured and that is the way trust develops"*

The team members explicitly mentioned the importance of team composition, specifically the fact that team members should complement each other with regard to skills and knowledge they have to offer to the team. They considered themselves lucky that they really complemented each other since team members had no say in team formation and were randomly assigned to the team. They divided roles and allocated subtasks based on the individual preferences and skills of team members, but at the same time assuring that the workload was divided equally. Also, team members mentioned the willingness of almost all team members to back-up for each other and helping each other to fulfill subtasks. Team members considered the team a real team and felt connected, and team members also met informally which enforced the perception of 'being a real team'. Team members perceived everyone as equal and decisions were made democratically, although one member was considered the team leader based on both being recognized as having the skills to do so and experiencing that this worked out as expected. Team leadership therefore was accepted and appreciated, although one team member mentioned the existence of power differences within the team with the team leader having more influence on process and product. Due to being effective as a team, the adequate distribution of skills within the team and role division based on that, team members stated that they did not experience an added value of tutor interventions during supervised meetings. The tips and incentives of the tutor were valued as helpful, but tutor initiatives to invite the team to reflect on team collaboration were considered less helpful since things were going well in their opinion. One team member summarized this as follows:

> *"The discussions about how we collaborate as a team were not very helpful, and even confusing. Reflecting on the team collaboration is of course important, but I guess that without doing this explicitly during supervised meetings, we would have reached the same results"*

The tutor supporting the team during the performance phases, taking over this task from the first tutor in week 4, confirmed this by mentioning that he really felt superfluous during most supervised meetings. In order to fulfill

Table 13

Summary table with all codes in all supervised meetings of Team X.

	Meeting 1	Meeting 2	Meeting 3	Meeting 4	Meeting 5	Meeting 6	Meeting 7	Meeting 8	Meeting 9	Total per code
TaRsGoals	12	10	9	7	5	5	7	1	1	**57**
TaRsStrategy	13	17	4	4	19	27	22	17	18	**141**
TaRsSkills	2	0	0	4	0	1	6	2	0	**15**
TaRsRoles	5	7	1	9	8	6	15	2	8	**61**
TaRgContent	10	6	7	13	11	9	8	9	15	**88**
TaRgTaskFb	10	13	6	1	16	10	11	14	6	**87**
TaRgSocial	3	1	2	10	1	0	11	1	10	**39**
TaRgTeamFb	2	1	0	9	8	3	3	1	3	**30**
OffTask	1	0	0	1	0	0	1	0	0	**3**
Total per meeting	**58**	**55**	**29**	**58**	**68**	**61**	**84**	**47**	**61**	
SMM-Task	25	27	13	11	24	32	29	18	19	**198**
SMM-Team	7	7	1	13	8	7	21	4	8	**76**
MPM-Task	20	19	13	14	27	19	19	23	21	**175**
MPM-Team	5	2	2	19	9	3	14	2	13	**69**
Tutor interventions										
TuFbTaRg	7	7	6	8	2	2	5	3	3	**43**
TuFbTaRs	4	6	2	1	0	1	2	2	0	**18**
TuFbTeRg	5	2	1	9	2	1	0	1	1	**22**
TuFbTeRs	1	1	1	9	5	3	1	1	1	**23**
Total per meeting	**17**	**16**	**10**	**27**	**9**	**7**	**8**	**7**	**5**	

TaRsGoals	team interaction on goals and final outcomes	SMM-Task	task-related shared mental model
TaRsStrategy	team interaction on task execution strategies		
TeRsSkills	team interaction on distribution of expertise	SMM-Team	team-related shared mental model
TeRsRoles	team interaction on task allocation and roles		
TaRgContent	team interaction on process of task execution	MPM-Task	task-related mutual performance monitoring
TaRgTaskFb	team interaction on a member's performance		
TeRgSocial	team interaction about the team collaboration	MPM-Team	team-related mutual performance monitoring
TeRgTeamFb	team interaction on a member's commitment		
TuFbTaRg	tutor feedback and/or advice aimed at the team's decisions on task strategies		
TuFbTaRs	tutor feedback and/or advice aimed at the team's decisions on project goals		
TuFbTeRg	tutor feedback and/or advice aimed at team member's contribution to collaboration		
TuFbTeRs	tutor feedback and/or advice aimed at the role division and collaboration strategies		

his role as a tutor he felt obliged to explicitly invite the team to reflect on the quality of team collaboration from time to time, although he also noticed the team members being competent enough to effectively manage teamwork themselves.

Case 2 – Team Y | Team Y (4 males, 2 females) collaborated on the assignment, and team formation was decided by the teacher by randomly assigning these five students to the team.

Results of the Team Collaboration Evaluator show relatively distributed scores on all four scales during three phases of teamwork. Also, the scores gradually fall back and become more distributed in the second and third phase of teamwork (See Figure 21 for an overview of scores on all items in three measurements). The scores in phase 1 are especially distributed on the items 'consensus on task strategy' and 'awareness of each-others' competences' of the 'shared mental model' scale, on 'respecting each other' and 'being a team' of the 'mutual trust scale', and to a lesser extent on 'monitoring teamwork' and 'flexibility' of the 'mutual performance' scale. Since all scores fall back in the next stages and become more distributed, the team apparently does not agree on many task and team aspects and is not satisfied with team collaboration and results. Distributed scores in the first stage are not surprising, but distribution should decrease during the process of teamwork as a result of building trust and developing shared mental models, which in turn is conditional for team maturation (Fransen, Erkens, et al., submitted). It seems that team Y did not develop these shared mental models in time given the extremely distributed scores on the items of the 'shared mental models' scale in phase 2 and lower scores on that scale in phase 3. Also, scores on the 'mutual trust' scale are extremely distributed in phase 2 and again lower and even more distributed in phase 3. Apparently, one member was very satisfied with teamwork and team results in phase 3, but it is not clear if these high scores on all items are representative for what this team member really experienced. He or she might have had other reasons for filling out the questionnaire in this way.

Team Y had 9 unsupervised face-to-face meetings ranging from 15 minutes to 1 hour and 15 minutes, and 9 supervised meetings ranging from 30 to 50 minutes. Analyzing unsupervised meetings shows that team Y elaborately dis-

cussed the goals of teamwork early in the process, but kept on discussing these goals until meeting 5 (See Table 14 for an overview of entries on all codes during all unsupervised team meetings). They discussed strategies during almost all team meetings, but more extensively during meetings 2 to 4. Skills were not discussed at all and roles were only discussed in the first meeting, though they were encouraged to do so in the Initial Paper assignment. Team Y discussed task-management in all meetings, although not extensively, but the team members did not provide each other with task-related feedback, except during meeting 2, which is surprising since task execution just started and the results of individual performance could not have been available at that time. Team collaboration was not discussed in an early stage, only later in the process, more specifically during meeting 8, and the team only discussed team members' contributions to team collaboration in meeting 6.

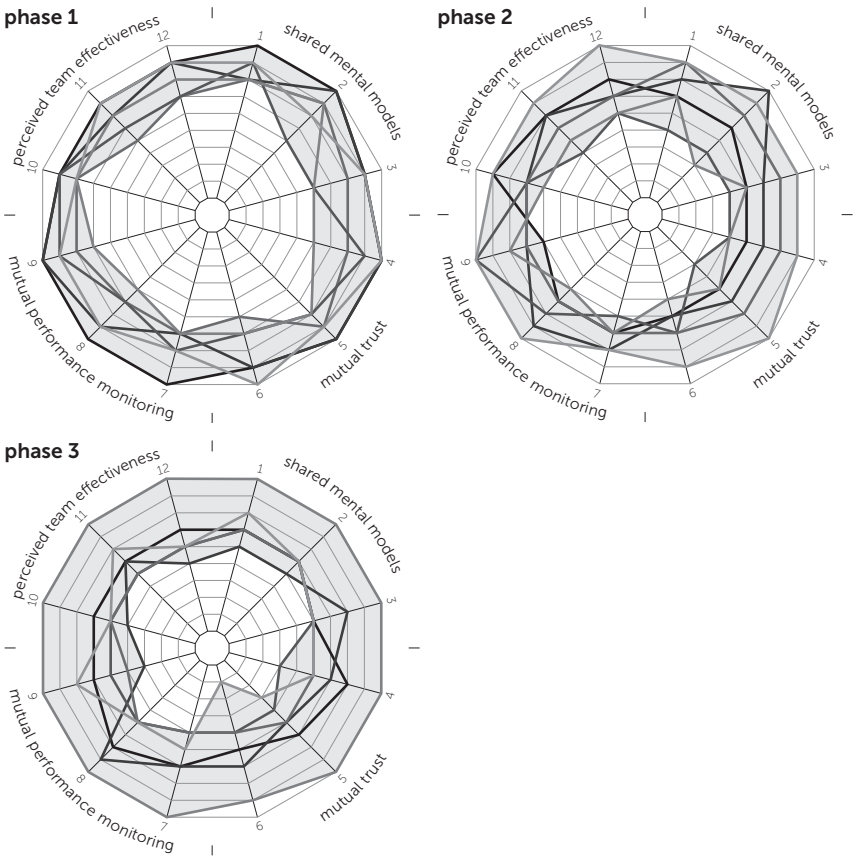

Figure 21

Overview of scores on all items of the Team Collaboration Evaluator in three phases of teamwork of Team Y.

Table 14

Summary table with all codes in all unsupervised meetings of Team Y.

	Meeting 1	Meeting 2	Meeting 3	Meeting 4	Meeting 5	Meeting 6	Meeting 7	Meeting 8	Meeting 9	Total per code
TaRsGoals	84	50	19	35	21	3	1	13	3	**229**
TaRsStrategy	11	20	19	18	12	11	8	19	9	**127**
TaRsSkills	0	0	0	2	0	1	1	1	0	**5**
TaRsRoles	29	1	4	0	2	3	1	0	0	**40**
TaRgContent	14	7	10	10	6	3	9	7	13	**79**
TaRgTaskFb	0	14	2	1	2	1	1	3	1	**25**
TaRgSocial	0	3	0	0	2	4	0	6	1	**16**
TaRgTeamFb	0	0	0	0	0	17	0	2	7	**26**
OffTask	0	3	0	1	0	0	0	0	0	**4**
Total per meeting	**138**	**98**	**54**	**67**	**45**	**43**	**21**	**51**	**34**	
SMM-Task	95	70	38	53	33	14	9	32	12	**356**
SMM-Team	29	1	4	2	2	4	2	1	0	**45**
MPM-Task	14	21	12	11	8	4	10	10	14	**104**
MPM-Team	0	3	0	0	2	21	0	8	8	**42**

TaRsGoals	team interaction on goals and final outcomes	SMM-Task	task-related shared mental model
TaRsStrategy	team interaction on task execution strategies		
TeRsSkills	team interaction on distribution of expertise	SMM-Team	team-related shared mental model
TeRsRoles	team interaction on task allocation and roles		
TaRgContent	team interaction on process of task execution	MPM-Task	task-related mutual performance monitoring
TaRgTaskFb	team interaction on a member's performance		
TeRgSocial	team interaction about the team collaboration	MPM-Team	team-related mutual performance monitoring
TeRgTeamFb	team interaction on a member's commitment		

The analysis of the supervised meetings shows a similar pattern of time investment with regard to discussing goals, and skills, but time investment on discussing task strategies increases in meetings 5 and 6, and also on task management in meetings 4 to 9 (See Table 15). Providing each other with task-related feedback is not important during teamwork, but team collaboration and team-members' contributions to team collaboration is being discussed in meetings 4, 7 and 8, probably due to the tutor discussing these issues with the team and inviting the team to reflect on team collaboration and results. This coincides in meetings 4 and 7 with

a substantial increase in tutor interventions, especially with regard to team issues. Meeting 4 seems to mark the start of a transition phase since discussions on strategies intensify. However, since there is no increase in team members providing each other with feedback on the results of individual performance in the following meetings, the team probably did not adapt teamwork to become effective as a team and to speed up team performance. Although the discussion on roles was resumed in meetings 4 and 7, it probably did not result in re-dividing roles and/or re-allocating subtasks within the team and therefore did not have an impact on team performance. It seems likely that a team-related shared mental model was not developed, given the fact that the team members' skills were not discussed at all during the whole process. Given the fact that goals were discussed until meeting 5 and discussions on strategies were resumed after the tutor intervened during meeting 4, team Y probably did not develop a sufficiently elaborate task-related shared mental model in time. Not having developed these shared mental models in an early stage of teamwork might explain the fact that the team could not adapt team and task strategies during a transition phase, resulting in falling back on team and strategies they already showed during the first performance phase and therefore not performing better during the second performance phase.

Team Y can be characterized as task-oriented, but not as effective, probably due to not having developed a task-related and team-related shared mental model in an early stage of the process. Team members stated:

> *"The process is very slow and we sometimes encounter communication problems or personal problems among group members."*

> *"We had to adapt the business plan according to the feedback of the teacher, but some team members did not come to school to work on the last corrections and these who were present had to back-up for them"*

Team members confirmed the findings from the Team Collaboration Evaluator and the analysis of team meetings in the team interview in both the preliminary questionnaire and group interview, although only three students filled out

the preliminary questionnaire and no answers were given on open questions in this questionnaire. Team members considered their team as not very effective, mainly due to communication problems, lack of leadership, and not meeting each other informally to compensate for shortcomings in coordination and to prevent communication problems. Teamwork resulted in everyone doing his/her part and just collecting these individual contributions to produce final results, without making adjustments and without any fine-tuning. It therefore could have been helpful if a team leader had monitored the process and scheduled what should be delivered when to be able to discuss the results as a team. The inconsistency of the final results became clear during the final presentation of the prototype and the business plan before the experts (i.e., the Dragons), which was expressed by one team member as follows:

> *"Our presentation really sucked, I felt like an idiot, because they were asking questions but our answers were ridiculous because we were not prepared for that."*

The team did not explicitly discuss the distribution of skills within the team since they assumed that everyone had to take up a specific role to learn new skills instead of making the most of the skills one already has developed. Therefore, the assigned team leader lacked the skills to effectively coordinate teamwork which was acknowledged by all team members, but since roles within the team were divided in an early stage, re-dividing roles was difficult and the team decided to carry on as agreed upon at the start. One member expressed this as follows:

> *"A team needs someone who takes responsibility to lead the team and who decides on what direction the team should go. It is not that we as a team do not have the competences, we did not effectively combine these resources"*

Communications problems were also partly the result of not having someone in the team to coordinate teamwork, which resulted in a lot of information not being shared in time or not at all. One team member mentioned:

> *"It happened several times that I went to school for a team meeting that was scheduled at for instance eleven o'clock, experiencing that by arriving at school it appeared that an email was sent just half an hour earlier to cancel the meeting due to some members being absent."*

It is remarkable that team members define trust as '*to rely on each other to do what is agreed and to deliver results in time*', they do not have an opinion about the quality of mutual trust within their team, although the scores on the questions on mutual trust in the preliminary questionnaire are distributed, especially on 'appreciating each other's qualities', 'trusting each other to meet agreements made', 'openness of the team to discuss differences of opinion', and 'trusting each other's qualities to accomplish the task'. Apparently, mutual trust was not very well established within the team, which also might explain why the team did not develop a task-related and team-related shared mental model, since a sufficient level of initial trust in an early stage of teamwork seems to be conditional for that (Fransen et al., 2011). The lack of trust also explains why the teams mentioned that a 'code of conduct' with rules as well as 'punishments' and 'penalizations' to maintain these rules, might have helped the team to manage teamwork effectively. It is also remarkable that team members mentioned that the tutor helped the team to effectively discuss task and team issues during team meetings, and although not all members agreed on that, one member proposed the following during the group interview:

> *"The tutor really showed us how to make team meetings more efficient, so it would be helpful if the tutor not only attends the supervised meetings, but attends all team meetings to monitor teamwork"*

This statement reflects the need for leadership or coordination in this team. Additionally, during the group interview team members emphasized the importance of a tutor not only being focused on coaching the team to effectively collaborate, but also supporting the team with regard to task execution. To this end the tutor must be aware of task characteristics, goals and deadlines to be met, and the

	Meeting 1	Meeting 2	Meeting 3	Meeting 4	Meeting 5	Meeting 6	Meeting 7	Meeting 8	Meeting 9	Total per code
TaRsGoals	43	22	25	11	10	12	1	6	1	**131**
TaRsStrategy	12	9	18	9	24	27	8	4	8	**119**
TaRsSkills	0	0	0	1	0	2	0	0	0	**3**
TaRsRoles	3	5	4	11	3	1	9	2	6	**44**
TaRgContent	9	4	6	16	17	12	16	4	19	**103**
TaRgTaskFb	5	0	3	0	2	1	7	0	0	**18**
TaRgSocial	0	2	3	17	1	2	19	18	1	**63**
TaRgTeamFb	2	1	4	8	0	1	24	5	0	**45**
OffTask	0	0	0	0	0	0	0	0	0	**0**
Total per meeting	**74**	**45**	**63**	**73**	**57**	**58**	**84**	**39**	**35**	
SMM-Task	55	31	43	20	34	39	9	10	9	**250**
SMM-Team	3	5	4	12	3	3	9	2	6	**47**
MPM-Task	14	4	9	16	19	13	23	4	19	**121**
MPM-Team	2	3	7	25	1	3	43	23	1	**108**
Tutor interventions										
TuFbTaRg	4	5	0	9	5	3	6	0	12	**44**
TuFbTaRs	6	3	2	1	2	9	0	1	0	**24**
TuFbTeRg	3	3	1	7	0	1	12	2	0	**29**
TuFbTeRs	3	6	2	11	0	1	11	3	0	**37**
Total per meeting	**16**	**17**	**5**	**28**	**7**	**14**	**29**	**7**	**12**	

TaRsGoals	team interaction on goals and final outcomes	SMM-Task	task-related shared mental model
TaRsStrategy	team interaction on task execution strategies		
TeRsSkills	team interaction on distribution of expertise	SMM-Team	team-related shared mental model
TeRsRoles	team interaction on task allocation and roles		
TaRgContent	team interaction on process of task execution	MPM-Task	task-related mutual performance monitoring
TaRgTaskFb	team interaction on a member's performance		
TeRgSocial	team interaction about the team collaboration	MPM-Team	team-related mutual performance monitoring
TeRgTeamFb	team interaction on a member's commitment		
TuFbTaRg	tutor feedback and/or advice aimed at the team's decisions on task strategies		
TuFbTaRs	tutor feedback and/or advice aimed at the team's decisions on project goals		
TuFbTeRg	tutor feedback and/or advice aimed at team member's contribution to collaboration		
TuFbTeRs	tutor feedback and/or advice aimed at the role division and collaboration strategies		

nature of deliverables that must be produced. The tutor should be oriented at both the team and the task and must have knowledge of both group dynamics and the nature of the assignment.

Cross-case analysis

Findings of the analysis of the two learning-teams show that both teams are primarily task-oriented, which confirms the findings in previous studies reporting that learning-teams in the context of higher education tend to be pragmatic and aim at delivering results in time (Fransen, Erkens, et al., submitted; Fransen et al., 2011; Fransen, Kirschner, et al., submitted). Although both learning-teams collaborated on the same assignment during the same period of time, under the same conditions and supported by the same tutors, teams differed with regard to performance and effectiveness.

Team X was perceived as effective by its members given the relative high scores on all scales of the Team Collaboration Evaluator and a rise of these scores during the process, which was confirmed during the team interview. The analysis of the team communication showed that team X shifted form focusing on developing a task-related shared mental model to focusing on task management and updating the task-related mental model. Also, team X probably developed a team-related shared mental model early in the process, although this was predominantly realized in unsupervised meetings. During supervised meetings the team was invited by the tutor to reflect on task execution and team collaboration, especially in the meetings before the transition phase. During the transition phase team X sped up team performance by adapting task strategies, re-allocating subtasks to back-up for one member who did not perform as agreed, and by intensifying the process of peer-review. Though team X encountered some problems with the loss of a team member, they solved this and delivered the final results in time. The team did seem to successfully adapt its strategies due to having developed a task-related and team-related shared mental model early in the process of teamwork which probably is conditional for effectively making decisions during a transition phase. The team divided roles based on the distribution of skills within the team which resulted also in one member being

both an effective and accepted team leader who watched over democratic decision making within the team. The tutor did not have to intervene to support effective teamwork, since the team was capable of doing it themselves, but the tutor was valued for offering tips and incentives with regard to task execution.

Team Y was perceived as ineffective by its members given relative low and distributed scores on all scales of the Team Collaboration Evaluator and these scores falling back during the process of teamwork, which was confirmed during the team interview. The analysis of the team communication showed that team Y focused mainly on developing a task-related shared mental model during unsupervised meetings and not at all on developing a team-related shared mental model. In supervised meetings the team was forced by the tutor to reflect on task execution and team collaboration, resulting in discussions with the tutor taking up almost one-third of the time during several of these meetings. Team Y also seemed to experience a transition phase, but this was predominantly triggered by tutor interventions and did not result in successfully adapting team and task strategies to improve team performance. Team Y did not encounter real conflicts within the team during the process, but this does not imply that the team became effective in the transition phase. This can be explained by the team not having developed a sufficiently elaborate task-related shared mental model and not having developed a team-related shared mental model at all. The team hardly discussed team collaboration and team issues during meetings, except when initiated by the tutor. Also, team members did not socialize outside team meetings, but only met each other in formal team meetings. Team Y did not have an effective team leader, which was labeled by the team members as an important cause for not becoming effective as a team. Team members emphasized the importance of tutor interventions to make team meetings more efficient, to help the team to reflect on the quality of teamwork, and to support the team in task execution. Additionally, the team more or less proposed that a tutor should take up the role of team leader when a team lacks leadership.

The analysis of team communication of both teams confirmed that ad-hoc learning-teams with a focus on goals and strategies and collaborating during a fixed

period of time often go through a transition phase to adapt task and team strategies to enhance team performance and to deliver final results in time (Fransen, Kirschner, et al., submitted). The analysis also confirmed that teams probably must have developed a sufficiently elaborate task-related and team-related shared mental model to successfully adapt the task and team strategies during the transition phase (Fransen, Erkens, et al., submitted). In other words, learning-teams must have reached a minimal level of maturation before entering a transition phase in order to become effective and to perform well during a second performance phase. An immature team entering a transition phase apparently does not have the necessary task and team skills to successfully adapt to changing environmental demands and to anticipate approaching deadlines in order to become effective in a later stage, in spite of tutor interventions during the process. The analysis also shows that team leadership may help to become effective as a team, provided that team members trust each other, equality is guaranteed, leadership is accepted and based on the leader being sufficiently skilled for that role, and democratic decision making is a rule within the team. Immature teams probably also need leadership, but this implies someone to decide on the direction to go, to monitor the teamwork, to coordinate subtask execution, to solve conflicts, and to maintain a 'code of conduct' through penalization. However, this type of leadership seems to imply being a 'mediator' with sufficient expertise to analyze team behavior (Rupprecht, Strasser, Gruber, & Harteis, 2010), and this expertise is less likely available within student learning-teams.

Conclusions and discussion

Two case studies and a cross-case analysis were carried out to confirm the findings of previous studies as well as to explore perceived effects of tutor interventions. The findings of previous studies were confirmed which implies that student learning-teams in the context of higher education tend to be pragmatic and task-oriented to deliver final results in time to get a grade, and that minimal levels of initial trust probably are conditional for developing a task-related and team-related shared mental model

(Fransen et al., 2011). Additionally, it confirmed that developing task-skills and team skills probably is conditional for a learning-team to become effective and that ad-hoc learning-teams tend to proceed through a transition phase to adapt team and task strategies in order to meet the deadline and deliver final results (Fransen, Kirschner, et al., submitted). Furthermore, it confirmed that having developed a sufficiently elaborate task-related and team-related shared mental model as a team probably is conditional for effectively adapting team and/or task strategies during a transition phase, which means that learning-teams probably must reach a minimal level of maturation to adapt successfully during a transition phase (Fransen, Erkens, et al., submitted).

This study also offers insight in the role of leadership, more specifically in relation to team maturation. In ad-hoc short-term learning-teams in which a sufficient level of initial trust is established in an early stage, a task-related and team-related shared mental has been developed, and role division and subtask allocation is based on skills distribution within the team, leadership is usually allowed to the most skilled and committed team member and accepted by all members in the team, provided that contributions of all team members to the task and the team are equally valued and democratic decision making is guaranteed. This type of leadership is similar to what is called *emergent leadership* (Heckman et al., 2007) which is leadership which changes and emerges based upon the need for the reinforcement, creation and ongoing evolution of team structures that guide the actions of team members). It refers to a shift in leadership from distributed first-order leadership in early stages of teamwork (i.e., task coordination and group maintenance) to centralized second-order leadership in later stages (i.e., transforming team structures to improve task execution, reinforce cohesion, and deal with environmental demands. This second-order leadership is *action-embedded*, implying that a team member only gets permission to lead after contributing substantially to the team. However, first-order distributed leadership is conditional for acceptance of second-order centralized leadership, since (1) team members have to agree on that, (2) the emergent second-order team leader must

already have exhibited first-order leadership behavior, and (3) a team must have developed accurate task-related and team-related mental models (Heckman et al., 2007). In teams without sufficient initial trust, shared mental models, and role division based on distribution of skills, leadership is not likely to emerge, but probably is needed given low team performance and the loss of team orientation and motivation of team members. Such a team tends to opt for leadership that is less democratic / more centralized to deal with the critical situation (Hogg et al., 2004), while this leadership also requires the leader to be a mediator to effectively solve team conflicts (Rupprecht et al., 2010).

This study sheds some light on the role of task orientation of learning-teams, which seems to be somewhat in conflict with the condition that a team-related shared mental model has to be developed in an early stage also to become effective as a team. Although learning-teams in the context of higher education tend to be pragmatic and task-oriented, effective teams seem to also develop a sufficiently elaborate team-related mental model which might be explained by the fact that team members are motivated and committed to the team and for that reason regularly meet informally. Informal social interaction seems to compensate for not investing too much time in team meetings developing a team-related shared mental model. This confirms research on the importance of both task-related interaction and social interaction for a team to become effective (Kreijns et al., 2003; Van den Bossche et al., 2006). Additionally, students gradually develop a *professional identity* (Nyström, 2009) starting with a non-differentiated identity (i.e., diffuse boundaries between the private and professional spheres of life), via a compartmentalized identity (i.e., separation between the different spheres), towards an integrated identity (i.e., integration of the private and professional spheres), which also may explain the relative low interest in project assignments of students having a non-differentiated identity or compartmentalized identity, versus growing interest in project assignments reflected by both task and team commitment of students with an integrated identity, especially if they perceive autonomy, competence and social relatedness (Minnaert et al., 2011).

Finally, the perceived effect of tutor interventions seems to differ according the level of maturation of a learning-team. In this study, the tutor who supported both learning-teams starting from week 4 intervened in a similar way in both teams, but these tutor interventions were valued differently by the teams. A mature team probably prefers to handle team conflicts itself unaided by a tutor, perceiving tutor initiatives to force the team to reflect on team collaboration as not helpful. A mature team probably prefers a task-oriented tutor that gives advice on task management, which is logical since learners cannot elaborately imagine task outcomes because they do not have the necessary expertise but must develop it by collaborating on the learning assignment. An immature team will likely need more tutor support aimed at both team collaboration and task management. If a team also lacks leadership, it probably will see the tutor as substitute for the missing team leader.

This study has its limitations. Firstly, only two teams were analyzed and conclusions may therefore not be generalized. Secondly, students were all international students and thus were from different cultures. Although all were more or less of the same age and are enrolled in the same program, group dynamics may differ from group dynamics in teams with students with the same cultural background. Students stated that this assignment offered them the opportunity to learn to collaborate in a multicultural team, but this means that it also was a variable that might have influenced team maturation differently in the teams. Finally, the project was well organized and students had to produce intermediate deliverables on fixed deadlines based on formats provided by the institution. The first deliverable was an initial paper with a mission statement and a team contract. This first assignment forced teams to discuss task issues and role division in an early stage of teamwork which might have accelerated the development of a task-related and team-related shared mental model.

This study shows the importance of developing a sufficiently elaborate task-related and team-related shared mental model in an early stage of teamwork for a learning-team to become effective. However, it also shows that there are constraints to overcome in order to realize that. Most important is that students usually must learn to

collaborate effectively, do not have the expertise to imagine elaborate models of outcomes of a complex learning assignment, and team orientation might be low due to not having influence on team composition and the resources or having negative experiences with collaborating in previous assignments. Therefore, a learning-team probably needs tailor-made support by an experienced tutor with knowledge of both group dynamics and the characteristics of the learning assignment.

CHAPTER 7

General Conclusions and Discussion

This chapter presents the main findings of the research and limitations of the research are being discussed. Additionally, the implications for theory and practice are reflected on and opportunities for future research are being proposed.

Introduction

This dissertation reports about a research project investigating factors influencing the emergence of team effectiveness of learning-teams in collaborative learning practices in the context of higher education. The complexity of group dynamics and the number of variables mediating learning-team effectiveness resulted in focusing on a qualitative approach in this research to explore and explain the emergence of team effectiveness within the perspective of team development and team maturation, with respect to the characteristics of learning-teams in educational contexts. First, the main findings of the studies will be presented and theoretical and practical implications will be discussed. Next, the limitations of the research project will be discussed, as well the opportunities for future research.

Collaborative learning is a widely appreciated approach in higher education based on the social constructivist paradigm that knowledge has to be (re-)constructed based on debate and argumentation, which will ultimately result in deep learning. Collaborative learning in higher education is often operationalized as case-based, problem-based or project-based learning in which learning and production are combined, although the focus will be on learning. At the same time this pedagogical approach is also aimed at learning to collaborate by offering students a setting that equals settings they will experience in their professional life. Therefore, knowledge acquisition and expertise development are often combined with learning to become a professional team worker. It is not surprising that student learning-teams often are not effective given the fact that students are not experts in the field and effectively collaborating also has to be learned due to minimal experience with professional teamwork.

The research started with the assumption that student learning-teams in collaborative learning practices in the context of higher education may become more effective if the learning-teams are tested and/or trained on effectively collaborating. To do so, it must be established which variables influence learning-team effectiveness in what way and which of these variables can be influenced before the start or in an early stage of a collaborative learning practice. Therefore, the main research question for this research project was: Which variables mediate the effectiveness of

learning-teams in collaborative learning practices in higher education in what way and how can the emergence of team effectiveness be facilitated and supported in an early stage of teamwork?

Student learning-teams in higher education usually are ad-hoc teams collaborating on a complex assignment during a restricted period of time with learning as the main goal of that activity. Team effectiveness in that context is defined in terms of the quality of learning outcomes and the quality of team collaboration, expressed as the perceived satisfaction of the needs of individual team members (Hackman, 1990). It is important to establish which variables influence the emergence of learning-team effectiveness in early stages of teamwork, since learning-teams usually collaborate during a restricted period of time and must become effective as a team in an early stage.

Main findings

First the findings of a literature review on team effectiveness are reported which resulted in the development of a conceptual framework on learning-team effectiveness. Next, the findings of the validation study on core aspects of this framework are reported, followed by a report of the findings of case studies and cross-case analyses.

Developing the conceptual framework | First, the conceptual framework for the research was developed to establish which variables mediate learning-team effectiveness in what way. Given the fact that most of the research on team effectiveness stems from teamwork in work settings, findings of work-team research had to be investigated and critically analyzed to decide which variables also mediate learning-team effectiveness in educational settings. It must be acknowledged that learning-teams in educational settings equal task teams or project teams in organizational setting to some extent, but are also different regarding specific aspects and team characteristics. Broadly stated, the primary goal of a work-team is a product and learning is nice but secondary, while the primary goal of a learning-team is learning and the product (e.g., a problem solution or a project) is nice but secondary. Learning-teams in educational settings also differ from ad-hoc teams in work settings regarding the distribution of power status and expertise within the team; all learning-team members are learners

and as such have the same power status and the same limited expertise. Also, learning-teams have no influence on the environment and the resources, because the assignments are fixed and resources are absent and/or cannot be controlled. Learning-teams do not have to be efficient with respect to their product, since deep learning may also be the result of costly debates and negotiations, and suboptimal production of a final task solution (i.e., learning is the ultimate goal, producing the task solution is additional). Finally, most learning-teams are short-term teams and team members are focused primarily on finishing the task in time for grading.

Learning-team development and maturation | Since learning-teams probably develop and mature during a process of teamwork, the variables mediating learning-team effectiveness probably will have a different impact in the various stages of learning-team development. Since learning-teams are ad-hoc teams and team composition often cannot be influenced by the students, a group of students starting on an assignment have to become a team first in order to become effective. It is likely, therefore, that learning-teams will develop by passing through a set of stages, although it depends on previous experiences of the team members with teamwork as well as the composition of a given team whether a team has to proceed through all stages. At the same time, due to the existence of preset deadlines for result delivery, solving task-related problems will also influence learning-team development, which means that learning-teams usually experience a turning point, and therefore a transition phase, when the deadline approaches, resulting in changing task strategies and performance in order to deliver final results on time (Gersick, 1988). The stages of team development usually include forming (i.e., getting to know each other and the task at hand), storming (i.e., establishing positions and roles within the team), norming (i.e., reaching consensus on goals and strategies), and performing (i.e., reaching conclusions and delivering results), after which the team is dismantled (Tuckman & Jensen, 1977). The developmental perspective for learning-teams in higher education was derived from the Team Evolution And Maturation model or TEAM model, stating that team maturation implies the development of task skills and team skills and both type of skills should converge in order to become effective as a

learning-team (Morgan et al., 2001), and therefore combines existing theories on team development into one team-development model. Figure 22 presents the adapted TEAM model.

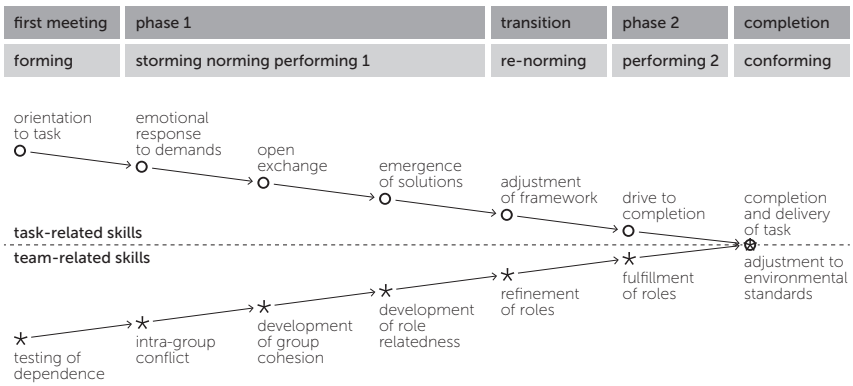

Figure 22

Essentials of the TEAM model with teamwork phases, team development stages, and convergence of task-related skills and team-related skills during team maturation (adapted from Morgan et al., 2001, *Journal of General Psychology*, 120(3), p.281).

Research on work-team performance and work-team effectiveness established five key factors mediating team performance and team effectiveness and three coordinating and supporting mechanisms (Salas et al., 2005), which are to some extent applicable for student learning-teams in educational settings. The coordinating and supporting mechanisms are *mutual trust*, *shared mental models* and *closed loop communication*, and the factors are *team orientation*, *team leadership*, *mutual performance monitoring*, *back-up behavior*, and *adaptability*. The coordinating mechanisms are distinguished from the factors (i.e., behavioral components), the first being conditional for updating the last.

Team orientation and team leadership are not considered key variables in the context of learning-teams in higher education and are left out of the conceptual framework, since team orientation is difficult to influence and vulnerable due to differing attitudes of students towards collaborative learning, and team leadership usually is not an issue in learning-teams since equal participation is important and team leadership is not needed in most situations. Mutual trust is not considered crucial for the effectiveness of ad-hoc student learning-teams, but probably will be of some influence during team maturation starting with calculus-based trust in an early stage of teamwork and evolving to knowledge-based trust in later stages (i.e., from assuming

trustworthiness to experiencing trusting behavior of others in the team). Developing a shared mental model as a team in early stages is important to become effective as a team, especially since learning-team members usually lack the expertise needed to imagine elaborate final outcomes and are highly depending on each other for successfully completing the task. Shared mental models are conditional for teams to collaborate effectively but at the same time are the objectives of collaborative learning. Closed-loop communication is important throughout the whole process of team collaboration, particularly during performing stages in order to monitor the teamwork effectively, but the nature of this communication will depend on the type of learning assignment and task complexity. Mutual performance monitoring differs according to the characteristics of a learning assignment with performance monitoring equaling the monitoring of teamwork in work settings for project-based learning, which means that it will be crucial during both performing stages as well as during the re-norming stage to decide if everything is on track and whether the outcomes meet the intended quality. Back-up behavior and adaptability are probably important during the re-norming stage (i.e., the transition phase) and second performing stage with back-up behavior mediating learning-team effectiveness when workload distribution problems arise and adaptability mediating learning-team effectiveness in situations of

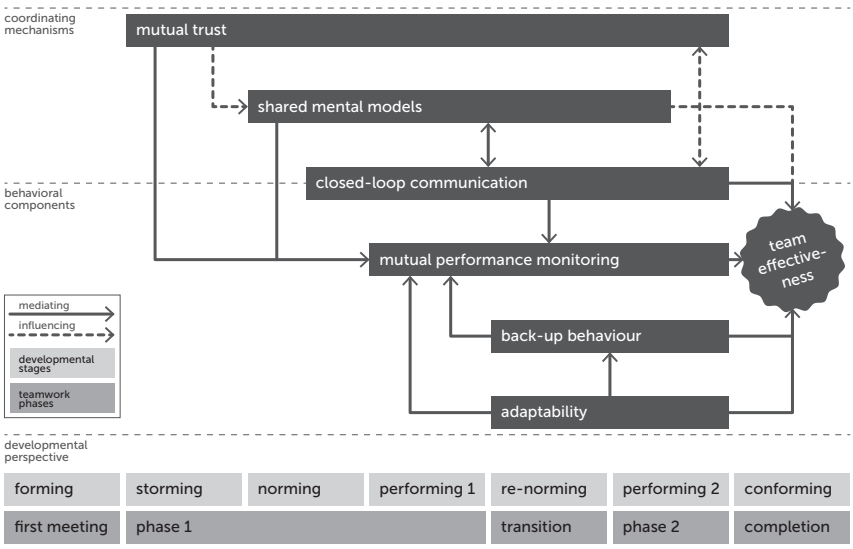

Figure 23

The conceptual framework on learning-team effectiveness presenting variables mediating team effectiveness.

changing environmental demands. Both back-up behavior and adaptability probably will mediate learning-team effectiveness if subtasks have to be reallocated within the team to meet an approaching deadline. Figure 23 presents the variables mediating learning-team effectiveness.

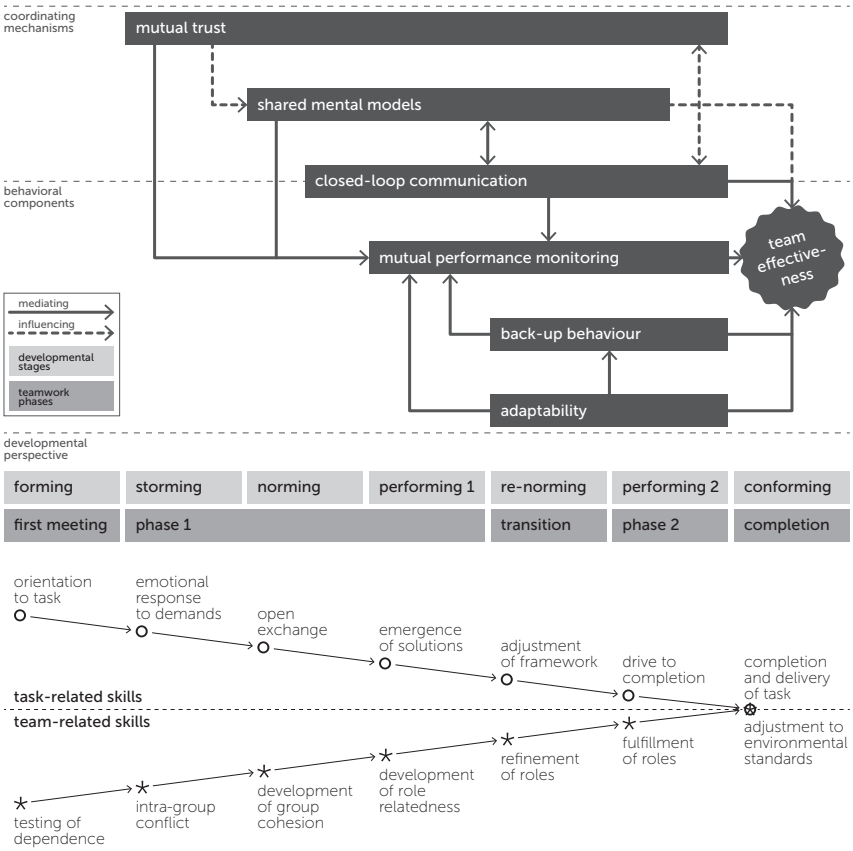

Figure 24

The complete conceptual framework on learning-team effectiveness presenting the variables mediating team effectiveness within the perspective of learning-team development.

The complete conceptual framework for this research project presents the variables mediating learning-team effectiveness within the perspective of team development and the stages in team maturation offer a frame for positioning the variables. Figure 24 presents the complete conceptual framework.

Testing the conceptual framework | In the conceptual framework on learning-team effectiveness at least three variables are considered important during teamwork and in earlier stages of team development. It was hypothesized that a sufficient level of mutual trust and shared mental models

are conditional for effective mutual performance monitoring with mutual performance monitoring mediating the effect of both variables on team effectiveness. The model was tested, which showed the impact of shared mental models on team effectiveness, directly as well as indirectly through mediation by mutual performance monitoring. No direct influence of mutual trust on learning-team effectiveness was found and also no indirect influence through mediation by mutual performance monitoring, only small effects of mutual trust on shared mental models were measured. Apparently, a sufficient level of initial mutual trust is necessary for developing shared mental models as a team, which in turn influences team effectiveness, either directly or mediated by mutual performance monitoring. Mutual performance monitoring also is of influence on team effectiveness. Learning-teams in higher education tend to be pragmatic which probably implies that mutual trust is focused on a shared expectation within the team of team member reliability with respect to the subtasks being carried out as agreed. Although mutual performance monitoring is also important, the effect on learning-team effectiveness was less than expected, probably because the impact of mutual performance monitoring is partly compensated by having developed elaborate shared mental models in an early stage as a team, implying that all team members know what to do, how to do it, and who does what, and consultation and discussion during team collaboration can be minimized.

Although the validity of the core aspects of the conceptual framework was tested and therefore the importance of team and task awareness for a learning-team to become effective was confirmed, the developmental perspective was not explored. In order to investigate the importance of the variables mediating learning-team effectiveness in different stages of teamwork the strategy in this research project was adapted into a qualitative approach. Based on case studies and cross-case analyses the relationships between learning-team development and variables mediating team effectiveness were further explored and partly explained to establish the importance of these variables in different stages of teamwork for the emergence of learning-team effectiveness.

Exploring team maturation and team effectiveness | Four case studies and a cross-case analysis were carried out to explore the importance of the variables mediating learning-team effectiveness in different stages of teamwork. The importance of team and task awareness for a learning-team to become effective was confirmed. Learning-teams probably must develop shared mental models in an early stage of teamwork and sufficient levels of initial trust seem to be conditional for developing these shared mental models. A learning-team probably also has to balance its focus between the team aspects and task aspects to develop both team-related and task-related skills. Task-related skills imply the orientation to the task and an open exchange of ideas to establish the goals and strategies as a team. Team-related skills imply solving initial power conflicts within the team and testing the interdependence to develop team cohesion and to effectively define roles within the team. Imbalance in both types of skills development may be repaired during a transition phase, but only if a learning-team has developed a team-related and task-related shared mental model and a sufficient level of mutual trust in an early stage of teamwork, since only then can the team adapt its strategies, refine the team roles and re-allocate the subtasks within the team. Learning-teams that focus both on team and task aspects in an early stage of teamwork tend to become effective sooner and adjustments in task and team strategy based on role re-division and subtask re-allocation are less likely during the transition phase. Such learning-teams will probably implement a few minor adjustments in team and task strategy to speed up performance in order to deliver the final results in time. However, all ad-hoc student learning-teams in higher education seem to pass through such a transition phase, although the impact the transition phase on task strategy and team performance seems to depend highly on the quality of the shared mental models developed in an early stage of teamwork and the level of initial mutual trust.

Explaining team maturation and team effectiveness | The exploration of team maturation and the emergence of learning-team effectiveness was based on data from questionnaires and a team interview and therefore focused on the team members' perceptions of the team's development and effectiveness. In order to further explore and possibly explain learning-team maturation and the emergence of team effectiveness,

an 'outsider' perspective had to be added to complement the 'insider' perspective. The team communication during face-to-face team meetings of the learning-teams was analyzed and the findings were triangulated with the results of the interviews. The analysis confirmed that learning-teams usually proceed through a transition phase during the process of teamwork but seem to differ with respect to the adjustments made in teamwork strategies, role re-division and subtask re-allocation during the transition phase, with teams having developed sufficiently elaborate shared mental models based on initial mutual trust in an early stage of teamwork showing only limited adjustments. The data analysis also confirmed the pragmatism of student learning-teams in higher education, resulting in predominantly focusing on task aspects and only limited on team aspects. The analysis of the team communication shows that if teams did not reach an agreement on goals and strategies before a transition phase, teams either resume discussions on goals and strategies in the transition phase leading to adaptations in strategy, role re-division and/or subtask re-allocation, or to changing the strategy of teamwork radically when a consensus on goals and/or strategy cannot be reached in the transition phase. A learning-team that cannot reach an agreement on the goals and strategy during the transition phase may have had a basic agreement on goals and strategies before the transition phase, but apparently did not develop a team-related shared mental model in time which probably is conditional for a team to effectively decide on adaptations in role division and subtask allocation. If both a task-related and team-related shared mental model is not developed before the transition phase, only radical changes in the teamwork procedures may result in a learning-team delivering final results on time. This possibly means one team member taking the lead and deciding as an authoritarian leader on usually drastic adaptations in task strategy, role division and subtask allocation.

Replication and exploring tutor interventions | Learning-team maturation and the nature of variables mediating team effectiveness was explored in four case studies in an ecological setting with limitations regarding age distribution of the students and characteristics of the learning assignments. Therefore, two additional case studies and a cross-case analysis were carried out in a different context under better con-

trolled conditions regarding team composition and learning assignment, ruling out the limitations of the previous case studies. Team sizes varied from 5 to 6 members and students were randomly assigned to a team. The teams all carried out the same assignment and were supported by the same tutors. The case studies and cross-case analysis confirmed the findings of the previous case studies which imply that learning-teams tend to be pragmatic and primarily task-oriented, aiming at delivering results in time to get a grade. Additionally, minimal levels of initial trust probably are conditional for developing a task-related and team-related shared mental model. Both task skills and team skills are likely to be conditional for a team to become effective and an ad-hoc short-term student learning-team usually experiences a transition phase in which the team adapts their task and/or team strategies to meet a preset deadline and deliver final results on time. It also was confirmed that a learning-team probably must have developed both a task-related and a team-related shared mental model before entering the transition phase to be able to successfully adapt the task and/or team strategies during the transition phase. In other words, learning-teams probably must have reached a minimal level of maturation to adapt successfully and become effective as a team in a later stage of teamwork.

These case studies also offered insight in the role of team leadership in ad-hoc short-term student learning-teams, more specifically in effective and ineffective teams. In effective learning-teams a minimal level of trust is established early in the process and both a task-related and a team-related shared mental model is well developed before the learning-team enters a transition phase, probably resulting in the team not having to drastically adapt task and team strategies, but only speeding up team performance to meet a preset deadline. Decisions are made democratically in such learning-teams and leadership is distributed, or the most skillful team member is allowed to be team leader or team coordinator. Assigning a team leader might be established at the start due to being obliged to do so by the tutor (i.e., a teacher supporting the learning-team during the process by reflecting on task execution and team collaboration) or by the institution, but leadership may also emerge during the process. In order to reinforce learning-team maturation and team performance, this type of emergent leadership

may shift from a distributed first-order leadership in an early stage of teamwork to a more centralized second-order leadership in later stages, provided that the team leader gets permission to lead from the other team members and is acknowledged as most skillful team member to do so, and that he or she already performed first-order leadership during the early stages of teamwork. Also, it is likely that the emergent leader can only be successful if mutual trust is guaranteed and shared mental models are well developed in order to democratically lead the team through a transition phase and a second performance phase by reinforcing team cohesion and transforming task execution to speed up team performance and meet a preset deadline. In less effective teams with a low level of mutual trust and less well developed shared mental models this type of leadership is not likely to emerge, although team leadership is probably needed given the low team performance and the problems and conflicts that have to be solved. During a transition phase these teams probably must adapt team and task strategies drastically in order to meet a preset deadline and deliver final results, which may imply one team member claiming autocratic leadership and leading the team towards delivering the best possible final results given the circumstances. For this to happen, however, this member must be acknowledged by the other team members as competent in order to be accepted as the team leader. Additionally, the team probably must succeed in updating both the task-related and team-related shared mental model during the transition phase in order to successfully adapt task and team strategies and become effective.

Tutor interventions are perceived differently by effective and less effective learning-teams, which imply that these interventions probably should be tailor-made according to team characteristics and the level of team maturation which influence the needs of a learning-team. It is likely that an effective learning-team has developed a task-related shared mental model conditional for deciding as a team on goals and strategies. The team probably also has developed a team-related shared mental model conditional for role-division, monitoring team collaboration and dealing with conflicts. Also, since both types of shared mental models are well developed, a sufficient level of mutual trust probably has been established as well. In such teams tutor interven-

tions purposefully aimed at reflecting on team collaboration and solving conflicts within the team usually are less appreciated since these teams are capable of managing teamwork themselves. Such learning-teams probably only appreciate tutor interventions aimed at supporting the team in task management and improving team performance. Less effective teams, especially teams without a team leader, most likely need a tutor to support the team in solving task problems and/or team conflicts. Moreover, such teams probably tend to claim the tutor to become the substitute for the team leader they cannot provide for themselves. Less effective teams usually are less mature teams and that is why they will likely invite the tutor to act as a leader to support the team on team collaboration and task management.

Finally, the fact that ad-hoc short-term student learning-teams in collaborative learning practices in higher education tend to be pragmatic and primarily task-oriented seems to be in conflict with a learning-team having to develop a team-related shared mental model in an early stage, since learning-teams usually do not seem to invest time during formal team meetings to establish a team-related shared mental model. Nevertheless, team orientation of the members of effective teams seems to be strong, probably as a result of team members regularly meeting informally to socialize. This may result in swiftly developing initial trust which probably is conditional for developing both shared mental models, and it specifically may support the development of a team-related shared mental model. Therefore, socializing during the informal team meetings may compensate for being predominantly task-oriented as a learning-team during formal team meetings.

Theoretical an practical implications

Despite the limitations of this research and the predominantly qualitative approach that was chosen, this research has some theoretical and practical implications which will be discussed separately.

Theoretical implications | This research contributed to the understanding of the dynamics of team collaboration in the perspective of collaborative learning in higher education, more specifically to the insight in the nature of mediating variables and the emergence of learning-team effectiveness

during teamwork within the perspective of learning-team development. To this end, the relevance of research on work-team effectiveness in organizational settings for the research on learning-team effectiveness in educational settings has been analyzed which resulted in hypothesizing that the variables mediating team effectiveness in workplace settings are also applicable to learning-teams in educational settings, but with some important restrictions. Learning-teams differ from work-teams regarding the distribution of power and expertise within the team, the influence on environment and resources, the purpose of collaboration, the necessity of efficiency, and the duration of teamwork. These characteristics do have an impact on the nature of variables mediating team effectiveness and their expected influence in the different phases of teamwork. Additionally, learning-team development seems to be specific due to the restricted duration of teamwork and the students acting pragmatically with balancing teamwork with competing personal interests and perceiving deadlines to be met and grading as most important. Learning-team development is linear progressive to some extent and the developmental stages often include a transition phase when the final deadline approaches. Therefore, variables mediating team effectiveness must be discussed within the perspective of learning-team development and learning-team characteristics mentioned before. Based upon the literature and findings from the case studies the following may be concluded:

- Developing shared mental models probably is conditional for a learning-team to collaborate effectively, but since shared mental models are at the same time the objective of collaborative learning, they have to be considered a variable on two levels.
- Collaborating for restricted time periods and student pragmatism (e.g., getting it finished by date X, and Y is enough for a passing grade) will probably impact the importance of mutual trust in learning-teams.
- Effective learning-teams usually do not need team leadership, only coordination, although role division and inequality of participation often are important issues in collaborative learning practices, which could be dealt with by assigning roles.

- Team orientation is vulnerable due to attitudes of students towards collaborative learning as a result of past experiences with teamwork and therefore difficult to influence, but it can be stimulated if students experience less uncertainty through collaborating if teams are kept small and team composition is kept stable.
- Back-up behavior probably is important, although the extent to which a learning-team will show back-up behavior depends on commitment to the team and to teamwork, but backing-up may become helping out for reasons not related to team goals.
- Adaptability probably is less important for a learning-team with regard to responding at changing environments, since assignments are fixed and goals and deadlines are set and usually will not change, and therefore concerns in most cases changing strategies as a result of changes in the team and/or approaching deadlines.
- Communication, and more specifically closed-loop communication, is important, though the nature of communication will depend on the type of learning task and task complexity, with communication for developing a shared mental model and monitoring the production process in project-based learning, and for debate and negotiation in knowledge-construction situations.
- The nature of mutual performance monitoring probably differs according to the type of the learning assignment with mutual performance monitoring equaling the monitoring of teamwork in workplace settings for project-based learning, but monitoring being distributed in collaborative learning practices primarily aimed at knowledge construction due to the transactive nature of learning.

The conceptual framework is an attempt to integrate theories of group development into a context-specific model for learning-team development for discussing variables mediating learning-team effectiveness within this perspective. It therefore contributes to the need to address issues why groups develop differently, how different aspects of interaction are linked together, and what mechanisms underlie the transition from stability to instability and back again (Arrow et al., 2004). The con-

ceptual framework builds to some extent on the 'multiple sequence model of group development' (Poole, 1983), which is a dynamic contingency model of group development presenting group development as a process of continuously evolving tracks of group activities that intertwine over time, more specifically the task process activities (i.e., managing the task), relational activities (i.e., managing relationships among members), and a topical focus (i.e., issues of concern to the group at given points). If development on these tracks converges in a coherent pattern, phases of group development may be recognized (Poole, 1983), similar to the convergence of team skills and task skills in the TEAM model (Morgan, et al., 2001), which explains group development of ad-hoc learning-teams probably better. By combining the developmental perspective with the adapted Big Five framework, presenting the variables mediating team effectiveness, relationships between task activities, team activities and team development are becoming more explicit by addressing how aspects of interaction are linked together and what transitions a given learning-team may face and why. This framework offers insight in the relative importance of variables mediating learning-team effectiveness in different stages of learning-team development, but this has to be confirmed in future research. However, research on team effectiveness in collaborative learning settings should acknowledge the nature of variables mediating learning-team effectiveness and their influence in the different stages of learning-team development.

This research also had outcomes with regard to research instruments, more specifically a questionnaire measuring perceived learning-team effectiveness with 34 items on five independent variables mediating team effectiveness and the dependent variable team effectiveness itself. The questionnaire was validated by presenting it to a large group of students of which 161 students responded, and reliability scores were excellent. The Team Effectiveness Questionnaire (TEQ) may be useful for future research on team effectiveness in collaborative learning. Additionally, a short questionnaire was derived from this questionnaire named Team Collaboration Evaluator (TCE) with 9 items on the three key variables mediating learning-team effectiveness (i.e., shared mental models, mutual trust, mutual

performance monitoring) and 3 items on the perceived team effectiveness. The short questionnaire was used in the case studies for measuring the perceived team effectiveness and perceived quality of shared mental models, mutual trust and mutual performance monitoring in the different stages of teamwork and the reliability of all scales was excellent. Findings of the TCE were confirmed by findings of other qualitative and quantitative measurements and the outcomes reflected learning-team development. The TCE has the potential to become a 'team tester' to predict the emergence of learning-team effectiveness in an early stage of teamwork. To this end, this research must be replicated to test the TCE in a variety of educational settings with larger numbers of learning-teams. The outcomes of the TCE may inform the tutor in deciding on interventions to support a given learning-team in becoming effective as a team.

Practical implications | This research has practical implications since it offers some guidelines for effectively organizing, supporting and assessing collaborative learning in higher education:

- The conditions should be right for collaborative learning, which implies that the *assignment* must be complex and cannot be completed individually, but requires teamwork with team members highly depending on each other in order to be successful.
- A collaborative learning *assignment* should not be exclusively focused on product development with the team members applying previously acquired knowledge, but must also require that new solutions have to be developed and knowledge has to be (re)constructed.
- Learning-team *composition* usually is decided by the teachers and students have to deal with the other students assigned to their team, which implies that task and team skills have to be developed from scratch each time they start in a new team with a new assignment.
- Learning-teams must be supported through *tutoring* to become effective and the tutor has to balance his/her interventions on task and team issues given the needs and characteristics of a specific learning-team.
- *Tutoring* on both task management and team collaboration is probably important since students have to

collaborate on assignments from which they have to learn, which implies that they do not yet have the expertise to elaborate on the potential outcomes of learning.
- Students usually do not have any influence on the assignment and they also lack the *power and resources* to influence the environment. The fact that they often have to combine learning with producing solutions in practices of collaborative learning in higher education may complicate matters further, not in the least since learning-teams are ad-hoc teams collaborating during restricted periods of time.
- Not only the collaborative result of teamwork should be *assessed* by grading every team member equally, individual accountability is also important and assessment must reflect and value the team member's individual contributions to the task and the team.

Taking these conditions into account, it is not surprising that learning-teams are often ineffective and that the learning-team members need tailor-made tutoring to develop their team skills and task skills. Therefore, a tutor must have expertise with regard to both the content of the learning task and the dynamics of teamwork to be able to support a learning-team in developing team skills and task skills to become effective, especially when learning to collaborate professionally in a team is also considered important. From research we know that team orientation is vulnerable in learning-teams, especially if students have negative experiences with teamwork in collaborative learning. It is important that we prevent collaborative learning perceived as ineffective and demotivating and that we are aware of some important conditions that have to be met before confronting students in higher education with this pedagogical approach.

Limitations of this research

There are some limitations that were already reported in the subsequent studies that were carried out. These limitations will be summarized and briefly discussed here.

Considering the conceptual framework on learning-team effectiveness it is clear that only first steps were taken to validate this framework, and although findings confirmed core aspects of the model, further testing of the valid-

ity of the conceptual framework is needed, both through replicating this research in different educational settings with larger numbers of learning-teams and by designing experiments. Although the model with respect to the core aspects has been validated and these findings were confirmed in the case studies and cross-case analyses, it is still unclear what the exact nature is of mutual trust and mutual performance monitoring, and how adaptability and back-up behavior are related to learning-team characteristics and the type of assignment. Also, the closed-loop character of team communication has not been explored which means that relations between ineffective communication and team performance still have to be investigated. Furthermore, since developing shared mental models is also the goal of collaborative learning it is difficult to discriminate between shared mental models as a condition for teamwork and shared mental models as the outcomes of teamwork, since both types of shared mental models probably converge in the later stages of teamwork, especially when assignments are open and specifically designed to initiate knowledge construction activities. In the case of project-based learning both types of shared mental models probably are more easily to distinguish and can be investigated separately. In the final paragraph some differences between the types of collaborative learning in the context of higher education are being explored and presented to inform future research on collaborative learning in higher education.

Learning-team effectiveness in this research project was predominantly measured by self-reporting but should also be measured directly by assessing the outcomes of collaborative learning. Valid and reliable instruments must be developed for these measurements since grades students get for completing assignments are not reliable and cannot be used for that purpose. Measuring learning-team effectiveness within the perspective of learning outcomes is important since learning-teams may also learn at the expense of costly debates and negotiations, which in turn may result in relative low scores on the measurements of the perceived team effectiveness. Within the same perspective one may argue that team effectiveness should not be measured separately in the context of collaborative learning in educational contexts, since the ultimate goal

of such teams is deep learning leading to understanding and knowledge construction and not efficiently completing tasks and delivering the final products. In project-based learning, however, learning and product development are combined which resembles the future professional practice of students enrolled in most programs of universities of applied sciences. The characteristics of this type of collaborative learning practices will be further explored in the section presenting opportunities for future research.

The first case studies also had some limitations. The number of teams and students participating in these case studies was limited and conclusions may not be generalized. Also, the teams differed in size, male-female ratio, and in distribution of expertise due to age differences and variation in professional background of team members. Team maturation probably was a combination of a team visiting the usual stages of team development and team-specific dynamics based on the team's composition. Also, team assignments were comparable in size and complexity, but differed in nature and this may have had some influence on teamwork dynamics, more specifically regarding the nature of both the task-related and team-related shared mental model, as well as the characteristics of the team's mutual performance monitoring. This probably resulted in differences in how the learning-teams managed the task and assured the quality of results, since subtasks and final results differed according to the type of assignment a team had to complete. All students were experienced teachers and for that reason one may assume that they all have experienced collaborating in a team in an organizational setting. However, the findings seem to confirm that team and task skills are team and task-specific and have to be developed from scratch when starting on a new task with a new team. Also, teamwork of teams in organizational settings differs from teamwork of learning-teams in educational settings.

Most limitations of the first round of case studies were controlled in the second round of case studies, since teams were composed by randomly assigning students to a team, age distribution within the teams was limited and students not yet experienced teamwork in organizational settings, and teams collaborated on the same assignment. However, students differed in cultural background since the case

studies were carried out in an International Business Management Studies program. Group dynamics may have been influenced by cultural differences, especially since some students explicitly mentioned having perceived learning to collaborate in a multicultural team as a side-effect of the learning assignment. Furthermore, the assignment was strictly organized as a project with intermediate deliverables that had to be produced at fixed deadlines. The first deliverable to be produced was an initial paper in which a team had to report about its mission statement and preliminary product ideas, as well as on the way the team intended to organize the task execution and team collaboration. For that reason teams had to divide roles within the team at the start based on a prescribed format of team roles. This might have influenced the development of a task-related and a team-related shared mental model, although most teams did not mention the initial paper being of influence on deciding and reflecting on task strategies and team collaboration.

Opportunities for future research

The complexity of learning-team development and the number of factors influencing the emergence of learning-team effectiveness in a specific educational context offer a variety of opportunities for future research grouped in research regarding the variables mediating team effectiveness, research regarding the developmental process, and research regarding the relations between team and task issues.

Variables mediating learning-team effectiveness | The exact nature of the multidimensional construct of mutual trust in learning-teams must be explored further to explain how mutual trust influences the development of both types of shared mental models and the emergence of team effectiveness. Additionally, the nature and importance of back-up behavior and adaptability was not explored to explain their influence on team performance and team effectiveness. In this research, learning-team effectiveness was defined as effectively collaborating as a learning-team in completing an assignment but not in terms of the quality of learning results. Future research should also incorporate measurements on learning outcomes to explore and explain in what way effectively collaborating as a team influences the quality and the outcomes of learning. Furthermore, only a number of case studies

have been carried out to explore and explain the relations between the variables mediating learning-team effectiveness within the perspective of learning-team development. These case studies should be replicated in other educational contexts on a larger scale to confirm the findings.

Learning-team development | Perceived effects of tutor interventions were briefly explored but must be explored further to better understand which interventions at what stage of teamwork influence what type of learning-team in what way. In the long run experiments should also be designed and carried out to test emerging hypotheses with respect to the effects of tutor interventions on learning-team development in order to predict potential effects of tutoring in practices of collaborative learning in higher education.

The applicability of the conceptual framework developed in this research probably depends on the nature of a collaborative learning practice in a given context, which probably influences team development towards effectiveness. This might be explored in future research.

Task execution versus team collaboration | The nature of collaborative learning in higher education, especially in universities of applied sciences, depends on the nature of a learning assignment and the conditions during the process of teamwork with respect to tutor interventions and assessment. Given students' pragmatism it is likely that they will tend 'to deal with the assessment', which implies that assessment procedures determine what learning activities students probably will undertake to get a grade with minimum effort (Biggs, 2003). Therefore, aligning the intended learning outcomes with assessment procedures as well as tutor interventions is important in order to expect that the intended learning outcomes will be realized.

Concluding reflection | Although collaborative learning in the context of higher education is aimed at deep learning and understanding by (re)constructing knowledge through discussion, debate and negotiation, this constructivist pedagogical approach is often implemented as project-based learning in universities of applied sciences with product development considered the main focus of teamwork and meaningful learning the side-effect of collaborating on product development. Although this is understandable given the specific professional practices the students get educated for, it also bares a risk of focusing exclusively on

product development, which even may be enhanced by focusing on the assessment of the product quality and by supporting a team in task management towards product delivery but not focusing on the quality of learning and learning outcomes. Furthermore, learning to effectively collaborate in a project team is often considered an additional goal of collaborative learning which implies that a learning-team resembles a project team in a work setting instead of being a discussion group in an educational setting. Therefore, collaborative learning practices in higher education may be characterized by either focusing primarily on learning and (re)construction of knowledge or by focusing primarily on team performance and product development. Both types may be considered extreme positions of a continuum. Type of assignment, assessment procedures, and tutor interventions determine the position of a learning practice on this continuum. Both extreme types will be briefly characterized and the essential aspects of both types of collaborative learning practices are summarized in Table 16.

Assignments primarily focusing on team learning and knowledge (re)construction are characterized by offering students opportunities for discussing 'conceptual artifacts' and expanding on these artifacts by combining diverging knowledge of team members and reaching consensus after discussion and negotiation. Assessment procedures are focused on evaluating the quality of learning on group level as well as individual level by assessing the learning results in terms of deep understanding and the quality of the student's cognitive schemata. Tutor interventions are aimed at supporting the process of knowledge construction by encouraging team members' awareness of each-others' divergent knowledge and purposefully enhancing the discussion aimed at knowledge convergence, which may imply discussions taking more time and becoming inefficient at certain stages in order to enhance deep learning and improve the quality of learning outcomes. Teams in this type of collaborative learning practices are discussion groups and they are predominantly team-oriented.

Assignments primarily focusing on team performance and product development are characterized by opportunities to exchange the distributed expertise within the team and expand on it and apply it in product develop-

ment. Open and complex learning assignments usually offer more opportunities for creativity in product development. Assessment procedures are focused on evaluating the quality of the intermediate and final results by valuing the extent to which the results are an effective solution for a given problem. Tutor interventions are primarily aimed at supporting the team in task management and team collaboration, since the quality of the final results depends on the quality of teamwork, which also implies the efficiency of team collaboration. This is even more important if learning to collaborate in a team is also a goal of collaborative learning. Teams in this type of collaborative learning practices resemble project teams in work settings and are predominantly task-oriented.

The characterization of collaborative learning practices in higher education is a result of combining the findings in this research with insights from literature. Based on these assumptions it is hypothesized that if collaborative learning practices focus on deep learning and knowledge (re) construction, a learning-team may be characterized as a discussion group and findings of research on team performance and effectiveness in work settings are only partly applicable. If collaborative learning practices primarily focus on team performance and product development, findings of research on team performance and team effectiveness in work settings probably may be applied to some extent since a learning-team resembles a project team in a work setting. However, there are restrictions since learning-teams lack the power and resources to influence the environment and the learning-team members share limited expertise and cannot imagine elaborate outcomes at the start.

Table 16

Characteristics of collaborative learning practices with either a focus on product delivery or on learning.

Characteristics of collaborative learning practices in higher education

Product development (Task orientation)		**Knowledge construction (Team orientation)**
Complex open assignment with built-in interdependency aimed at application of expertise for product development.	**Assignment**	Complex open assignment with built-in interdependency aimed at constructing knowledge and reaching understanding.
Previous acquired knowledge and skills, expanded by codified knowledge for application in product design and developing professional expertise.	**Knowledge**	Previous acquired codified knowledge expanded by theory through discussion to reach a shared, deep understanding of conceptual artifacts and theory.
Awareness of distributed expertise in order to effectively apply the team's resources in product development.	**Process**	Awareness of knowledge divergence in the team to effectively discuss theory and establish knowledge convergence.
Efficiency is important since the team's performance depends on using all team members' resources efficiently.	**Efficiency**	Efficiency not important since learning might be the result of costly and time-consuming discussions and debates.
Initial mutual trust is important for establishing trusting behavior which implies everyone acting as agreed.	**Mutual trust**	Initial mutual trust is only important for establishing psychological safety in the team for an open exchange of opinions.
Shared mental models are conditional for a team effectively performing and they are to some extent the final results.	**Shared mental models**	Shared mental models are mainly the outcomes of collaborative learning and only partly conditional for teamwork.
Mutual performance monitoring aimed at keeping track of each-others' work and the effect on team performance.	**Mutual performance monitoring**	Mutual performance monitoring aimed at monitoring interaction and the effects of interaction on team learning.
Back-up behavior is important since both outcomes interdependency and task interdependency may be present.	**Back-up behavior**	Back-up behavior is less important since outcomes interdependency is more important than task interdependency.
Adaptability is important since changes in team and/or environment influence task execution and team collaboration.	**Adaptability**	Adaptability is less important since the process of knowledge construction will be less influenced by the environment.
Team effectiveness is primarily defined in terms of the quality of the product as the result of learning, and of satisfaction of the team members' individual needs.	**Team effectiveness**	Team effectiveness primarily defined in terms of the quality of team learning and individual learning, and of satisfaction of the team members' individual needs.
Tutoring aimed at enhancing awareness of the team's distributed expertise and monitoring and supporting teamwork.	**Tutoring**	Tutoring aimed at enhancing awareness of the team's knowledge divergence and supporting knowledge convergence.
Assessment aimed at evaluating the quality of final results and the process of teamwork leading to these results.	**Assessment**	Assessment aimed at monitoring the quality of learning and evaluating the quality of individual learning results.

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APPENDICES

Appendix A

Questionnaire for measuring the perceived learning-team effectiveness and conditions of the mediating variables.

Questionnaire for Measuring Learning-Team Effectiveness and Mediating Variables	
Shared Mental Models	
1	It was clear from the beginning what this team had to accomplish.
2	This team spent time making sure every team member understands the team objectives.
3	Group members understand what is expected of them in their respective roles.
4	Shortly after the start this team had a common understanding of the task we had to handle.
5	Shortly after the start this team had a common understanding of how to deal with the task.
Mutual Trust	
6	In our team we can rely on each other to get the job done.
7	Members of this team are able to bring up problems and tough issues.
8	People in this team sometimes reject others being different.
9	Working with members of this team, my unique skills and talents are valued and utilized.
10	It is difficult to ask other members of this team for help.
11	Group members keep information to themselves that should be shared with others.
12	No one in this team would deliberately act in a way that undermines my efforts.
Mutual Performance Monitoring	
13	We regularly take time to figure out ways to improve our team's work processes.
14	In this team, someone always makes sure that we stop to reflect on the team's work process.
15	My team members depend on me for information and advice.
16	I depend on my team members' information and advice.
17	When my team members succeed in their jobs, it works out positively for me.
Team Effectiveness	
18	I am satisfied with the performance of my team.
19	We have completed the task in a way we all agreed upon.
20	I would like to work with this team in the future.

Appendix B

Questionnaire (improved) for measuring perceived learning-team effectiveness and the conditions of the mediating variables.

1. As a team we fully agreed on what exactly has to be achieved with the assignment.
2. All team members fully agreed that we want to perform well as a team.
3. In our team everybody can trust that others will execute their tasks as agreed.
4. In our team every team member is entitled to have an opinion on goals or strategy.
5. As a team we fully agreed on the strategy to reach the objectives and execute the task.
6. All team members are aware of the qualities everyone has to offer in dealing with the task.
7. As a team we fully agreed on the functional role allocation within our team.
8. Important information is shared within our team without restrictions and at all times.
9. Asking other team members for help in executing a task is fully accepted in our team.
10. Every team member knows what is expected from him/her, given his/her role in the team.
11. As a team we fully agreed on how we will monitor the process and product quality.
12. All team members have a shared perception of what we are capable of as a team.
13. Difficult issues can always be discussed and conflicts will always be solved in our team.
14. My contributions and individual qualities are being valued by everyone in our team.
15. All members of our team take care of each other and respect each-other's interests.
16. As a team we schedule all activities and carry out these activities as planned.
17. As a team we frequently step aside and take some time to discuss the process.
18. It feels like being a group and as such we consider ourselves being a real team.
19. In our team there is always someone critically monitoring the process and results.
20. As a team we implemented democratic and effective procedures in decision-making.
21. Giving feedback on each-other's performance is standard practice in our team.
22. Communication was primarily aimed at evaluating the process and adjusting it accordingly.
23. As a team we used available means of communication effectively in all situations.
24. In cases of someone dropping out we re-allocated the work packages within the team.
25. In our team everyone was willing to advice of help someone else during task execution.
26. As a team we used everyone's feedback to improve our strategy and the results.
27. As a team we really were depended on each other to carry out the assignment.
28. I am very satisfied with the results we delivered so far as a team.
29. As a team we carried out the assignment and executed the task as agreed.
30. Every team member was involved at all time in decisions to adjust the strategy.
31. When circumstances change we easily adapt our goals and/or strategy as a team.
32. As a team we respond quickly on changes as a result of effective communication.
33. In general I am very pleased with the work climate during team collaboration.
34. In the future I would like to collaborate with the same team members again.

Appendix C

Items of the Team Collaboration Evaluator (TCE) with items measuring 'shared mental models' (i.e., 1, 2, 3), 'mutual trust' (i.e., 4, 5, 6), 'mutual performance monitoring' (i.e., 7, 8, 9), 'perceived team effectiveness' (i.e., 10, 11, 12), and one open question.

Below you will find twelve statements covering aspects of team collaboration. You are invited to rate your team on these aspects, based on your perception of the quality of team collaboration until this moment. Additionally you are invited to answer an open question about what you experienced as most important regarding the development of your team. Do not forget to register in which team you are and to mention your name on behalf of data processing. Data will only be used for research objectives and your privacy is guaranteed. Thank you for your co-operation.

1. The degree of agreement within your team on what exactly has to be achieved.

1 2 3 4 5 6 7 8 9 10

2. The degree of agreement in your team on how the task should be carried out.

1 2 3 4 5 6 7 8 9 10

3. The extent to which team members are aware of each other's competencies.

1 2 3 4 5 6 7 8 9 10

4. The extent to which team members respect each other and each other's contributions.

1 2 3 4 5 6 7 8 9 10

5. The extent to which team members are willing to support and help each other.

1 2 3 4 5 6 7 8 9 10

6. The extent to which team members feel connected to each other and to the team.

1 2 3 4 5 6 7 8 9 10

7. The extent to which your team monitors the quality of the process and the results.

1 2 3 4 5 6 7 8 9 10

8. The extent to which your team is able to adapt to new or changing circumstances.

1 2 3 4 5 6 7 8 9 10

9. The extent to which you value the effectiveness of the communication within your team.

1 2 3 4 5 6 7 8 9 10

10. The extent to which tasks are actually being carried out as agreed by your team.

1 2 3 4 5 6 7 8 9 10

11. The extent to which you are satisfied with the quality of the results delivered so far.

1 2 3 4 5 6 7 8 9 10

12. The extent to which you are satisfied about the quality of collaboration within your team.

1 2 3 4 5 6 7 8 9 10

13. What has been the most important event or intervention in the past week(s), and in what sense was the team collaboration influenced through that?

Appendix D

Questionnaire for measuring the perceived quality of team collaboration, presented online as preliminary questionnaire before the final team interview.

Characteristics of the assignment
The below questions relate to the assignment that the team accomplished.

1. Please indicate to what extent you experienced the assignment to be 'open', i.e. the degree to which new or own solutions could be developed.

closed	1	2	3	4	5	6	7	open

2. Please indicate to what extent the assignment was motivating to you, i.e. the degree of involvement [as regards content] and wanting to work on it.

not motivating	1	2	3	4	5	6	7	very motivating

3. Please indicate to what extent it is important for your motivation to have a say in determining the content of an assignment in collaborative learning.

not important	1	2	3	4	5	6	7	very important

4. Please indicate whether the assignment was focused more on applying knowledge or developing knowledge.

applying knowledge	1	2	3	4	5	6	7	developing knowledge

5. Please indicate the extent of complexity of the assignment with respect to its contents [= the number of connections that were to be or could be established between knowledge components and task aspects].

few connections	1	2	3	4	5	6	7	many connections

6. Please indicate to what extent the assignment was difficult to accomplish [= many part tasks that had to be completed and adjusted simultaneously or consecutively].

few part tasks; much adjustment	1	2	3	4	5	6	7	many part tasks; little adjustment

7. Please indicate to what extent the assignment was feasible considering the time given and the requirements set for its result.

not feasible	1	2	3	4	5	6	7	very well feasible

8. Please indicate the extent of interdependency between you and your team members in accomplishing the task, and with that the degree to which collaboration constituted an added value.

no need to collaborate	1	2	3	4	5	6	7	collaboration is necessary

9. Please indicate with a score from 1 to 10 the extent to which you found the assignment to be appropriate for collaborative learning.

1	2	3	4	5	6	7	8	9	10

10. Please write down anything you would like to add with respect to the collaborative learning assignment, and/or use this box to provide explanations to the answers given to the previous questions.

Characteristics of task accomplishment
The below questions relate to the team vision on goals, way of working and on the team's task statement.

11. Please indicate what was more important to the team: the shared goal that you as a team had defined or the personal goals of individual team members.

personal goals of team members	1	2	3	4	5	6	7	the shared team goals of team members

12. Please indicate whether within the team, attention was more focused toward the team [collaboration] or the task [the product that was to be delivered].

attention for process	1	2	3	4	5	6	7	attention for product

13. Characterize your team's way of working on a scale from 'ad hoc' to 'methodical', i.e., from 'wait and see' to 'making a plan and working accordingly'.

ad hoc	1	2	3	4	5	6	7	methodical

14. Within your team, was the focus more on the distribution of roles [position in the team, and a fitting part task for each member] or on the distribution of workload [equal workload for all members]?

distribution of roles; specific part tasks	1	2	3	4	5	6	7	distribution of workload; equal workload

15. Please indicate to what extent discussion and documentation of goals and working procedures contributed to the quality of the collaboration.

did not contribute at all	1	2	3	4	5	6	7	contributed a lot

16. Please indicate the relation between process orientedness and result orientedness within your team, i.e., between the 'how' and the 'what', with respect to the assignment.

process-oriented	1	2	3	4	5	6	7	product-oriented

17. Please indicate to what extent the team shared the same task statement, i.e. the degree to which all members aimed for the same result with the same effort.

task statement differed among members	1	2	3	4	5	6	7	task statement was the same

18. Please indicate whether the team concentrated more on working together or on completing the task.

concentrated on collaboration	1	2	3	4	5	6	7	concentrated on completing tasks

19. Please indicate with a score from 1 to 10 the extent to which you feel your team succeeded in developing a shared vision on its goals and the working procedures toward achieving these goals.

1	2	3	4	5	6	7	8	9	10

20. Please write down anything you would like to add with respect to working procedures and task statement of the team, and/or use this box to provide explanations to the answers given to the previous questions.

Characteristics of the collaboration
The below questions relate to the way in which the team members worked together.

21. Characterize the team with respect to the degree of space for contributing one's own personal vision and different perspectives.

limited space for differing visions	1	2	3	4	5	6	7	sufficient space for differing visions

22. Please indicate to what extent all information was shared within the team, i.e., whether all members could have the same information at their disposal at the same time.

information was often not shared	1	2	3	4	5	6	7	information was always shared

23. Please indicate to what extent team members appreciated each other's qualities and whether all could fully participate in the process.

qualities of some not appreciated	1	2	3	4	5	6	7	qualities of all members were appreciated

24. Characterize the team with respect to the degree to which team members trusted each other to meet the agreements made.

limited mutual trust	1	2	3	4	5	6	7	sufficient mutual trust

25. Please rate the team's 'openness', i.e. the degree to which differences of opinion and conflicts were discussed.

much remained discussed	1	2	3	4	5	6	7	everything was un-discussed

26. Please indicate to what extent team members had insight into and trusted each other's qualities in accomplishing the task.

no insight in what others had to offer	1	2	3	4	5	6	7	good insight in what others had to offer

27. Please indicate to what extent the personal interests of all team members were respected within the team.

no respect for each other's interests	1	2	3	4	5	6	7	full respect for each other's interests

28. Please indicate to what extent power differences occurred, which caused some team members to have more influence on process and product than others.

some members determined everything	1	2	3	4	5	6	7	everyone had equal influence within the team

29. Please indicate with a score from 1 to 10 how you felt about the quality of the mutual trust within the team, specifically during the initial phase of collaboration.

1	2	3	4	5	6	7	8	9	10

30. Please write down anything you would like to add with respect to the mutual trust within the team, and/or use this box to provide explanations to the answers given to the previous questions.

Characteristics of quality assurance
The below questions relate to the way in which the team implemented quality assurance and how communication was.

31. Characterize the way in which the team gave direction to the process, that is the degree to which this was done methodically and according to agreements made.								
reactive; ad-hoc and with mutual agreement	1	2	3	4	5	6	7	pro-active; methodical and without mutual agreement
32. Please indicate how the team conducted quality assurance of intermediate products, i.e., the degree to which this was done consistently and according to plan.								
occasional; ad-hoc; without distribution of roles	1	2	3	4	5	6	7	frequent; according to agreement; with role distribution
33. Characterize the type of feedback that team members gave each other, and how the feedback was dealt with within the team.								
feedback on the self; unclear processing of feedback	1	2	3	4	5	6	7	feedback on task; systematic processing of feedback
34. Please indicate to what degree team members were held accountable and addressed accordingly as regards the completion of their part tasks.								
difficult to address team members on part-task completion	1	2	3	4	5	6	7	easy to address team members on part-task completion
35. Characterize the type of team meeting during project duration, that is the relation between the time spent on team-oriented en task-oriented matters.								
team-oriented; social interactions	1	2	3	4	5	6	7	task-oriented; businesslike interactions
36. Please indicate to what extent the team used the available media [digital tools and face-to-face meetings] effectively in team communication.								
untargeted; ineffective	1	2	3	4	5	6	7	targeted; effective
37. Please indicate how the team dealt with the outcomes of team meetings during the full duration of the project, i.e. the degree to which agreements were documented and followed.								
incomplete archiving; inconstant follow-up	1	2	3	4	5	6	7	careful archiving; consistent follow-up
38. Characterize the team with respect to the choice of communication tools that were generally used, i.e. the relation between the use of physical meetings and meetings in a digital environment.								
use of mainly digital communication	1	2	3	4	5	6	7	use of mainly face-to-face communication
39. Please indicate with a score from 1 to 10 how you feel about the quality of team communication during the full duration of working together.								
40. Please write down anything you would like to add with respect to team communication and quality assurance, and/or use this box to provide explanations to the answers given to the previous questions.								

Concluding questions
The below questions relate to team composition and size, and subsequently you will be asked to write down your name and team number [for the purpose of data analysis].

41. Characterize the team composition with respect to diversity and team members' content expertise.

homogeneous; team members had identical ideas	1	2	3	4	5	6	7	heterogeneous; team members complemented each other

42. Characterize the team with respect to the influence team members had on process and product, i.e. the degree of leadership within the team.

no team leader; all equal	1	2	3	4	5	6	7	one obvious team leader; different positions within the team

43. Please indicate what conditions/factors are important for successful collaborative learning [more answers possible].
- specific team composition
- appropriateness of the assignment
- supporting information
- instruction and/or training
- coaching and supervision
- phasing of the process
- a digital learning environment
- individual assessment
- other:

44. Please indicate what communication tools are important for successful collaborative learning [more answers possible].
- e-mail
- chat-area
- discussion forum
- document sharing
- calendar/agenda
- other:

45. What could contribute to effective team meetings and effective team communication in collaborative learning [more answers possible]?
- assigning roles to team members
- assistance or protocols
- a digital environment
- specific coaching/supervision
- other:

46. What type of coaching should be provided in collaborative learning, and at what stage during the duration of the project [more answers possible]?
- process-oriented during initial phase
- product-oriented during initial phase
- process-oriented during concluding phase
- product-oriented during concluding phase
- other:

47. In your opinion, what is the most desirable team size for collaborative learning with this type of assignments?
- 2 members
- 3 members
- 4 members
- 5 members
- 6 members

48. Please use this box to provide any additional information about 'collaborative learning' that you would like to provide us and have not yet provided.

Appendix E

Protocol for the final team interview.

Topic	Question	Keywords
Assignment	A1. How do you value the team assignment?	Keywords: complexity, task size, interdependency.
	A2. In what way should the assignment be changed to enhance collaborative learning?	
Shared Mental Models	B1. In what way was the team contract helpful for developing a shared vision on goals and strategy as a team?	Keywords: shared vision, team goals, collaboration strategy, role allocation, planning.
	B2. Could you name something that might have helped to develop a shared vision on goals and strategy as a team?	Keywords: specific instruments, tutor interventions.
Mutual Trust	C1. How would you define mutual trust in a team, which is team members trusting each other?	Open question to explore how mutual trust is perceived.
Mutual Performance Monitoring	D1a. What went well in monitoring the process?	Keywords: providing feedback, processing feedback.
	D1b. What went wrong in monitoring the process?	
	D2a. What went well regarding quality assurance?	Agreements on procedures for quality assurance, execution of procedures as agreed, quality of feedback.
	D2b. What went wrong regarding quality assurance?	
	D3. In what way might monitoring the process and quality assurance be improved?	Keywords: role allocation, task distribution, specific monitoring instruments, tutor interventions, support in virtual environment.
Virtual Learning Environment	E1. Which functionalities in the virtual environment were useful for supporting collaborative learning and why?	Actual use of Blackboard [VLE], use of other applications?
	E2. What functionalities did you miss, but might have been helpful for the team in the virtual learning environment?	Functionalities students would have like to use for teamwork.
Interaction	F1a. What went well regarding team communication?	Perception of the quality of the team communication.
	F1b. What went wrong regarding team communication?	
	F2a. Which tutor interventions were helpful and why?	Students may provide positive and negative feedback without any restrictions/consequences.
	F2b. Which tutor interventions were less helpful and why?	
	F3. What other tutor interventions might be helpful in early stages of teamwork for a team to become effective?	Open question for tips.
Team Effectiveness	G1. What did help the team the most to become effective?	Exploring variables influencing team effectiveness.

Appendix F

Form for assessing the final team results.

Aspect	Assessment Criteria	I	S	G	E	Points
Subject Relevance	Relevance with respect to the Master Program					**10**
	Relevance for the professional practice of education					
Elaboration Quality	Argumentation for the intended learning outcomes					**10**
	Argumentation for the approach regarding elaboration					
Academic Quality	Quality and quantity of connections with theory					**20**
	Quality and quantity of academic references					
Final outcome Quality	Relevance and consistency of the final results					**30**
	Applicability of the final results in practice					
Reflection on process	Critical reflection on the results of the teamwork					**10**
	Critical reflection on the process of collaboration					
Presentation	Adequate choice of media for the presentation					**20**
	Language, lay-out and overall finishing					
Maximum points to be obtained						**100**

I = Insufficient
S = Sufficient
G = Good
E = Excellent

Summary

In our networked information age, the expectations of what higher education should achieve are rising and include being able to construct meaningful and valid knowledge. To achieve such goals, collaborative learning based on a constructivist paradigm where students become involved in a knowledge construction process using discussion and argumentation to achieve understanding has often been implemented as pedagogical approach. In higher education, students frequently collaborate on problem-based or project-based learning assignments and have to deliver products and/or solutions with knowledge-construction activities seen as intentional processes and new knowledge as effects of these practices. In this context, team effectiveness is conditional for the quality of learning-team collaboration, and as a result for the quality of collaborative learning. However, learning-teams are often ineffective, resulting in low quality learning results and the students' perception of collaborative learning as not being meaningful for their professional development. Learning-team effectiveness in this context is a function of the quality of the team's performance and the perceived fulfillment of the individual team members' needs. Teams working with conceptual artifacts based on a meaningful, open assignment designed to include built-in interdependencies whereby the team members collaborate with a shared intention of achieving deep learning, are most often experienced as effective teams. However, team effectiveness also depends on factors such as team formation, team members' characteristics, team decision-making strategies, and team leadership. This research explores the factors that mediate learning-team effectiveness, and assumes that establishing these factors offers opportunities to train learning-teams on effectiveness before starting or during the start-up phase of a collaborative learning practice.

Chapter 2 reports about the study aimed at exploring the characteristics of learning-teams in the context of higher education and critically analyzing the extent to which research on team effectiveness in work settings can contribute to an understanding of collaborative learning in educational settings with the goal of the development of a conceptual framework on learning-team effectiveness. Learning-teams in educational settings often differ from teams in organizational settings regarding the distribu-

tion of power and expertise within the team, the influence they have on environment and resources, the reason for collaborating, the need for efficiency, and the duration of the teamwork. These characteristics impact the nature of the factors mediating team effectiveness and their importance in different phases of teamwork. Also, learning-team development seems to be specific because of its restricted duration and the fact that students balance the importance of teamwork with the importance of their own personal interests, the perceived deadlines, and the grading of assignments. The study resulted in a conceptual framework presenting the variables mediating learning-team effectiveness within the perspective of team development. This model can be seen in Figure 2 in Chapter 2 (p. 24).

In the model, a distinction is made between coordinating mechanisms and behavioral components with the coordinating mechanisms (i.e., closed-loop communication, shared mental models, mutual trust) being conditional for updating the behavioral components. The behavioral components describe the learning-team's actions during teamwork (i.e., mutual performance monitoring, back-up behavior, adaptability) and are process characteristics of teams, some of which are directly related to team effectiveness. *Mutual performance monitoring* is crucial to the team's understanding of workload distribution problems and/or changes in task characteristics, and respectively to the extent to which *adaptability* and *back-up behavior* will mediate team performance. *Closed-loop communication* is both a behavioral component and a coordinating mechanism. The two other coordinating mechanisms are *shared mental models*, implying a shared understanding in a team that is conditional for setting team goals, deciding on strategies, allocating subtasks to team members, and monitoring team processes adequately, and *mutual trust*, implying the shared perception that every individual in the team will perform particular actions important to the team and will protect the rights and interests of all team members. The variables are presented in a *developmental perspective*, which provides a frame for positioning the variables and offers insight into which variable is important in which developmental stage to attain team effectiveness. The developmental perspective acknowledges that ad-hoc learning-teams have to develop as a team by visiting spe-

cific developmental stages, while also acknowledging the importance of the effect of deadlines on learning-team development and the emergence of a transition phase.

The analysis of the relevance of research on *work-team effectiveness* for research on learning-team effectiveness revealed that it is important to consider some limitations when applying the variables mediating team effectiveness in workplace settings to educational settings. Developing shared mental models, for example, is a variable that is conditional in work-teams for deciding on goals and strategies and for monitoring teamwork, but plays a role on two levels in learning-teams since shared mental models are conditional for a learning-team to effectively collaborate and their development is the objective of collaborative learning. Mutual trust is important for work-teams, especially long-term teams in organizational settings, but students' pragmatism will probably impact the importance of mutual trust in learning-teams (i.e., the assignment needs to be completed by a certain date for the team to get a grade). Team leadership is important in work-teams, especially when tasks are complex and/or addresses critical situations , but learning-teams usually do not need team leadership but rather coordination since equal participation is not only important in collaborative learning, but is often seen as a requirement by instructors. Team orientation as a preference for working with others facilitates team performance through better decision making and depends on the team's composition of work-teams, but is vulnerable in learning-teams since students usually have no say in team composition and also may have experienced teamwork negatively in previous collaborative assignments. For work-teams mutual performance monitoring is conditional for the team's performance, especially when a task is complex, but in learning-teams the nature of mutual performance monitoring differs according to the characteristics of the assignment. In the case of project-based collaborative learning with monitoring teamwork in learning settings is practically equivalent to monitoring teamwork in workplace settings while monitoring probably being distributed in knowledge-construction assignments due to the transactive nature of learning. Back-up behavior may lead to increased performance in work-teams and is probably also important for learning-teams, although the

character of this behavior may approach 'helping out' for reasons of a more personal character and not related to team goals, such as friendship. Adaptability is important for work-teams, especially if teams are being confronted with changes in the team's task and/or environment, but is less important for learning-teams since the assignments that need to be carried out and deadlines for delivering results do not change. Finally, closed-loop communication is important in both settings, though the nature of communication in learning-teams depends on the learning task and its complexity.

Chapter 3 reports about the study aimed at validating core aspects of the conceptual framework on learning-team effectiveness. Shared mental models, mutual trust and mutual performance monitoring were identified as important variables that possibly mediate team effectiveness in early stages of teamwork, and it was hypothesized that shared mental models and mutual trust are both important variables influencing learning-team effectiveness but that the effects are mediated by mutual performance monitoring. Nine teams participated and a questionnaire was used to measure the variables and the perceived effectiveness. The findings showed that shared mental models influence learning-team effectiveness directly as well as mediated by mutual performance monitoring. Mutual performance monitoring also influences learning-team effectiveness, but to a lesser extent. Mutual trust does not influence learning-team effectiveness, neither directly nor mediated by mutual performance monitoring; only a minimal level of (initial) mutual trust seems to be conditional for a learning-team to develop shared mental models. The combination of shared mental models and mutual performance monitoring was defined as *task and team awareness* which implies that a team must be aware of all aspects concerning the task execution and the team collaboration.

Chapter 4 reports about four case studies and a cross-case analysis that were carried out to further explore the importance of the key variables (i.e., shared mental models, mutual trust, mutual performance monitoring) in different stages of teamwork and to compare the four teams on team development and the emergence of effectiveness. In this study learning-team development and learning-team collaboration were explored from a predominantly insider

perspective by using questionnaires and interviewing the teams. Findings confirmed the importance of team and task awareness for a learning-team to become effective and therefore the importance of developing a task-related and team-related shared mental model as a team in early stages of teamwork. Minimal levels of initial trust are probably conditional for developing the shared mental models. Teams also have to balance their focus on team aspects and task aspects to develop team-related and task-related skills, and to combine these skills to become productive and effective. Ad-hoc learning-teams often go through a transition phase in which they may adapt team and task strategies to speed up team performance in order to meet a deadline and deliver final results. A limited imbalance in skills development may be repaired during the transition phase, but only if both shared mental models and initial trust are already present, since only then a learning-team seems to be able to adapt its strategies and refine roles to become effective in the final productive phase. Learning-teams that focus on both the team and the task seem to become effective in an earlier stage, and adapting goals and/or strategies and refining roles in the transition phase will probably not be necessary. Such teams probably require only small adjustments to become even more goal-oriented.

Chapter 5 reports about the same four case studies and cross-case analysis aimed at further exploring the importance of the key variables mediating team effectiveness in different stages of teamwork, but now from a predominantly outsider perspective by analyzing the team communication to establish the nature of how the task-related and team-related skills are balanced with respect to learning-team characteristics and team development. The team communication in team meetings during the whole process of teamwork was analyzed to explore what the teams focus on in the different stages of teamwork, as well as how leaning-team characteristics are related to the way a team balances the task-related and team-related skills. Comparing these findings with the findings of the team interview offered additional insight in a team's maturation. The findings confirmed the results of the previous studies, respectively the importance of developing a task-related and team-related shared mental model as a team in an early stage and a mini-

mal level of mutual trust probably being conditional for that, as well as learning-teams being pragmatic and predominantly task-oriented. Also, if a learning-team has developed shared mental models in an early stage it probably does not have to drastically adapt its strategies in a transition phase, but only adjust them to speed up performance. A team that does not reach an agreement on goals and strategies in an early stage must resume the discussion on goals and strategies during the transition phase, which probably will only result in establishing a task-related shared mental model if the team already developed a team-related shared mental model because this seems to be conditional for effectively deciding on role division, subtask re-allocation and adapting procedures for quality assurance. Also, the absence of an accurate team-related shared mental model probably interferes with team communication and might even lead to miscommunication and conflicts due to a lack of awareness of other team members' skills and preferences. In a team that did not develop both shared mental models before a transition phase, a type of authoritarian leadership may emerge with one member taking control and dictating new teamwork procedures in order to meet a preset deadline and deliver some final results.

Chapter 6 reports about two case studies and a cross-case analysis that were carried out in a different context to rule out some limitations of the previous case studies (i.e., age distribution, differences between the assignments) with similar composed learning-teams collaborating during a full semester on the same assignment. The outsider and insider perspectives were combined by analyzing the team communication in the team meetings, by presenting the short questionnaire in three phases of teamwork, and by interviewing the teams to obtain insight in how the variables mediate learning-team effectiveness within the perspective of team development and maturation. Also, the perceived effects of tutor interventions on team development and the emergence of effectiveness were explored. The results confirmed the findings from the previous case studies and cross-case analysis, more specifically that developing both shared mental models as a team in an early stage of teamwork is important and that learning-teams often experience a transition phase. Also, a learning-team probably must have reached a minimal level of team maturation to be

able to successfully adapt team and task strategies during this transition phase. It also showed that leadership may emerge in an effective learning-team as a result of the team accepting the leadership skills of a team member, which probably implies that the team already developed a task-related and team-related shared mental model and also sufficient mutual trust. This type of centralized second-order leadership is action-embedded and emerges from distributed first-order leadership in earlier stages of teamwork. In less effective teams this type of leadership probably will not emerge, and if leadership emerges it may tend to be less democratic in order to deal with the critical situation of low team performance and the approaching deadline for delivering results. However, if a less effective team also has to deal with conflicts it probably requires a leader of the mediator type to effectively solve the conflicts. These case studies also showed that team members of an effective learning-team regularly meet outside formal team meetings to socialize, which may compensate for being predominantly task-oriented as a team in formal team meetings, and this may therefore be conditional for developing an accurate team-related shared mental model as a team. The perceived effects of tutor interventions seem to differ according to the level of maturation with a mature learning-team probably preferring to handle team collaboration and task management itself, and a less developed team probably depending more on the support of a tutor with respect to team collaboration and task management, especially if leadership skills are absent in the team.

This research contributed to the understanding of the dynamics of team collaboration in collaborative learning in the context of higher education, specifically to the insight in which variables mediate learning-team effectiveness during the process of teamwork. The developed framework on learning-team effectiveness may therefore be useful for future research on learning-team effectiveness in higher education since it integrates theories of group development into one model for learning-team development for discussing the variables mediating team effectiveness. This research also resulted in a validated questionnaire measuring the variables mediating learning-team effectiveness and the perceived team effectiveness, which may be valuable for future research on collaborative

learning in higher education. Derived from this validated questionnaire, a short questionnaire was developed and tested in all six case studies which eventually may lead to the validation of an instrument to measure team effectiveness and team maturation in different stages of teamwork in an efficient way. This may also prove to be valuable for future research, as well as for tutors to decide on how to adequately support a learning-team in a collaborative learning practice.

This research also offers guidelines for effectively organizing, supporting and assessing collaborative learning in higher education. Collaborative learning assignments should be complex and must require teamwork with team members highly depending on each other, which implies that it should not be possible to complete a learning assignment individually. Additionally, a learning assignment must be open and aimed at developing a solution, which implies that knowledge has to be (re)constructed. Students usually have to develop task skills and team skills from scratch each time they are enrolled in a new ad-hoc learning-team collaborating on a new assignment since these skills are team and task dependent. Learning-teams probably also need tailor-made tutoring to become effective which involves team collaboration and task management, since the assignments are learning tasks and students have limited expertise and cannot imagine elaborate outcomes of teamwork. Both the results of teamwork and the contributions to the task and the team of each team member should be assessed to motivate team members to contribute to the team and task and to stimulate team orientation. Underestimating the complexity of collaborative learning as well as the importance of supporting this type of learning may lead to students not experiencing the added value of collaborative learning, resulting in their team orientation to decline and perceiving collaborative learning as counterproductive.

This research has some limitations. First of all, only the core aspects of the model on learning-team effectiveness were tested and further steps are necessary to validate the complete framework. Secondly, learning-team effectiveness was predominantly measured by self-reporting but this should also be measured directly by assessing the outcomes of collaborative learning, since deep learning may be the result of costly debates and negotiations reflected

by low scores on the perceived team effectiveness. Thirdly, the case studies had some limitations with respect to team composition, type of assignment, and characteristics of students which implies that findings cannot be generalized and must be interpreted cautiously.

There are many opportunities for follow-up research given the complexity of learning-team development towards effectiveness and the number of variables mediating the emergence of effectiveness. The multidimensional nature of mutual trust as well as the importance of back-up behavior and adaptability in learning-teams must be explored further. The case studies should be replicated on a larger scale in various educational contexts to confirm and validate the findings of these studies. Additionally, the effects of tutor interventions on learning-team development need to be further investigated, as well as the effects of different learning assignments and assessment procedures on the students' learning activities and their attitudes toward collaborative learning.

Collaborative learning assignments in higher education, especially in the context of the applied sciences, could be characterized by a focus on either knowledge construction or product development with the latter resulting in learning-teams resembling project teams in work settings with equal procedures for team collaboration, quality assurance and task management. However, learning-team members lack the expertise to imagine elaborate outcomes of learning and do not have the power and resources to influence the environment, which is why collaborative learning practices must be well organized, and learning-teams need to be adequately supported to become effective.

Samenvatting

De informatiemaatschappij stelt eisen aan het hoger onderwijs met betrekking tot het opleiden van kenniswerkers die geacht worden een bijdrage te kunnen leveren aan de ontwikkeling van betekenisvolle valide kennis. Om aan die eisen te voldoen wordt er steeds vaker ingezet op samenwerkend leren als didactische strategie, gebaseerd op het constructivistische paradigma waarbij ervan wordt uitgegaan dat kennis actief moet worden ge(re)construeerd op basis van discussie en argumentatie om te leiden tot begrip en diepgaand leren. In het hoger onderwijs wordt dit vaak geconcretiseerd in de vorm van probleemgestuurd leren of projectonderwijs, waarbij het leren wordt gecombineerd met het ontwikkelen van een oplossing of product, en waarbij gericht wordt gewerkt met en gestuurd op leeractiviteiten gericht op kennisconstructie. In de context van samenwerkend leren is teameffectiviteit een voorwaarde voor de kwaliteit van de samenwerking in leerteams, en daarmee voor de kwaliteit van samenwerkend leren. Leerteams zijn echter niet altijd effectief, wat resulteert in kwalitatief minder goede leerresultaten en bij studenten kan leiden tot de perceptie dat samenwerkend leren niet bijdraagt aan hun professionele ontwikkeling. Teameffectiviteit is in deze context een functie van zowel de kwaliteit van de teamprestaties als de mate waarin de teamleden ervaren dat wordt voldaan aan hun eigen verwachtingen. Er wordt vanuit gegaan dat teams die werken aan *conceptual artifacts* op basis van een betekenisvolle, open opdracht waarin de onderlinge afhankelijkheid is ingebouwd, en die als leerteam de intentie hebben om tot diepgaand leren te komen, ook effectief zijn. Teameffectiviteit wordt echter ook beïnvloed door factoren als de samenstelling van een team, de kenmerken van teamleden, besluitvormingsprocedures in een team, en leiderschap in een team. Dit onderzoek richtte zich op het verkennen van factoren die van invloed zijn op de effectiviteit van leerteams in het hoger onderwijs vanuit de veronderstelling dat het inzicht hierin de mogelijkheid gaat opleveren om leerteams gericht te trainen op effectief samenwerken voorafgaand aan of tijdens de opstartfase van een leerpraktijk waarin samenwerkend leren het doel is.

In hoofdstuk 2 wordt gerapporteerd over een studie die zich richtte op een verkenning van de karakteristieken van leerteams in het hoger onderwijs en op een kritische

analyse van onderzoeken naar teameffectiviteit in arbeidssituaties, om vast te stellen of de resultaten hiervan kunnen bijdragen aan een beter begrip van samenwerkend leren in een educatieve context. Het uiteindelijke doel is het ontwikkelen van een conceptueel kader met betrekking tot teameffectiviteit bij samenwerkend leren. Leerteams in een educatieve context verschillen van teams in bedrijfsorganisaties ten aanzien van de verdeling van macht en expertise binnen een team, de invloed die een team heeft op middelen en omgeving, het doel van de samenwerking, de noodzaak om efficiënt te werken als team, en de duur van de teamsamenwerking. Dit bepaalt mede hoe factoren die van invloed zijn op teameffectiviteit werkzaam zijn en de mate waarin ze werkzaam zijn in de verschillende fases van teamsamenwerking. Daarbij komt dat een leerteam zich als team op een specifieke wijze ontwikkelt omdat er meestal maar een beperkte periode wordt samengewerkt en omdat studenten geneigd zijn om hun inzet voor het team af te wegen tegenover persoonlijke belangen, zoals een te behalen positieve beoordeling. Deze studie resulteerde in een conceptueel kader waarin de variabelen die van invloed zijn op de effectiviteit van leerteams worden gepresenteerd vanuit het perspectief van de ontwikkeling als team. Het volledige conceptueel kader is te vinden in hoofdstuk 2 (figuur 2, pagina 24).

In het conceptueel model wordt een onderscheid gemaakt tussen de coördinerende en ondersteunende mechanismen (*coordinating and supporting mechanisms*) en de gedragscomponenten (*behavioral components*). Coördinerende en ondersteunende mechanismen zijn: communiceren met wederkerige interactie (*closed-loop communication*), een gedeelde visie hebben als team op de taakuitvoering en teamsamenwerking (*shared mental models*), en onderling vertrouwen (*mutual trust*). Gedragscomponenten zijn: het gezamenlijk monitoren van het proces en van de kwaliteit van de bijdragen van elk teamlid (*mutual performance monitoring*), hulpvaardigheid in het team (*back-up behavior*) en aanpassingsvermogen van het team (*adaptability*). Gedragscomponenten verwijzen naar de acties van een team tijdens het samenwerken en zijn daarmee procesvariabelen. *Mutual performance monitoring* is belangrijk om problemen met betrekking tot de werklastverdeling of veranderingen van omstandigheden

te traceren en bepaalt mede of *back-up behavior* en *adaptability* zullen bijdragen aan de effectiviteit. *Closed-loop communication* is zowel coördinerend en ondersteunend mechanisme als gedragscomponent (communiceren). *Shared mental models*, gedeelde mentale modellen maken dat een team in staat is gezamenlijke doelen te stellen, taken te verdelen en een strategie te bepalen. *Mutual trust* impliceert dat elk teamlid zich inzet voor het team en de belangen van de andere teamleden respecteert. Deze variabelen worden gepresenteerd in het perspectief van teamontwikkeling zodat zichtbaar wordt welke variabele in welk ontwikkelingsstadium belangrijk is om effectief te worden als leerteam. Daarbij wordt aangenomen dat een ad-hoc samengesteld leerteam zich als team moet ontwikkelen via het doorlopen van een aantal ontwikkelingsstadia. Hierbij wordt onder meer de invloed van deadlines op de teamontwikkeling erkend, alsmede het feit dat een leerteam een transitiefase kan doormaken.

Uit de analyse van onderzoek naar teameffectiviteit in werksituaties bleek dat enkele beperkingen in acht genomen moeten worden als de variabelen die teameffectiviteit bepalen in werksituaties worden toegepast in een educatieve situatie. *Shared mental models* zijn voor een team in een professionele organisatie van belang om doel en strategie te bepalen; bij een leerteam spelen ze een rol op twee niveaus want ze zijn zowel voorwaardelijk voor het samenwerken als voor het resultaat van het leerproces. *Mutual trust* of wederzijds vertrouwen is doorgaans belangrijk voor teams in werksituaties, met name bij teams waarvan de leden langdurig moeten samenwerken. Echter het pragmatisme van studenten in de meestal kortlopende leerteams is van invloed op de betekenis van *mutual trust*, omdat het tijdig afronden van de taak voor een beoordeling het belangrijkste is. *Team leadership* is belangrijk bij een team in een werksituatie, met name als een taak complex is of als sprake is van levensbedreigende situaties, maar bij een leerteam is de behoefte aan leiderschap waarschijnlijk minder groot en is een vorm van coördinatie voldoende, ook al omdat juist een gelijkwaardige bijdrage van alle teamleden aan het leerproces wordt verwacht. *Team orientation*, de voorkeur om met anderen in een team samen te werken, bevordert de prestaties van een team in een werksituatie, maar is afhankelijk van de

teamsamenstelling. Dat is lastig te beïnvloeden bij leerteams omdat studenten vaak geen invloed hebben op de teamsamenstelling en ze niet zelden negatieve ervaringen hebben met samenwerkend leren. *Team leadership* en *team orientation* werden vanwege de genoemde redenen niet als variabelen opgenomen in het model. Bij teams in werksituaties is *mutual performance monitoring* een voorwaarde om tot een goede teamprestatie te komen, bij leerteams is de betekenis ervan afhankelijk van het type taak. Bij projectonderwijs is *mutual performance monitoring* vergelijkbaar met wat van teams in werksituaties wordt verwacht, maar bij leertaken gericht zijn op kennisconstructie is het minder noodzakelijk om elkaars bijdragen te controleren vanwege het transactionele karakter van het leerproces. *Back-up behavior* zal in teams in werksituaties leiden tot hogere teamprestaties, maar kan bij leerteams de vorm aannemen van het helpen van de ander vanwege persoonlijke motieven die niets te maken hebben met de teamdoelen die bereikt moeten worden. *Adaptability* is belangrijk bij teams in werksituaties, met name als teams vaak geconfronteerd worden met veranderingen in het team of in de omgeving, maar bij leerteams is er doorgaans minder sprake van veranderingen omdat de leertaken en bijbehorende voorwaarden vast staan en tijdens het proces meestal niet veranderen. *Closed-loop communication*, wederkerigheid in de communicatie is belangrijk voor teams in beide contexten, al zal het karakter van de communicatie bij leerteams afhankelijk zijn van de complexiteit van een leertaak.

In hoofdstuk 3 wordt gerapporteerd over de validering van de kernaspecten van het model, waarbij *shared mental models*, *mutual trust* en *mutual performance monitoring* worden gezien als de belangrijkste variabelen die de effectiviteit van leerteams in een vroeg stadium van de teamsamenwerking kunnen beïnvloeden. Daarin werden drie aannames getoetst, namelijk dat *mutual trust* en *shared mental models* invloed uitoefenen op de teameffectiviteit, maar dat die effecten worden gemedieerd door *mutual performance monitoring*. Negen teams participeerden in het onderzoek, waarbij vragenlijsten werden gebruikt om de variabelen en ervaren effectiviteit te meten. Het onderzoek toonde aan dat *shared mental models* de grootste invloed op de teameffectiviteit hebben, zowel rechtstreeks als

gemedieerd door *mutual performance monitoring*. Mutual performance monitoring heeft ook invloed op de effectiviteit, maar die invloed is duidelijk bescheidener. *Mutual trust* heeft geen directe invloed op de teameffectiviteit en ook niet indirect via *mutual performance monitoring*, al moet er wel een basis van onderling vertrouwen zijn om *shared mental models* te ontwikkelen als team. *Shared mental models* in combinatie met *mutual performance monitoring* werd omschreven als *task and team awareness*, ofwel het als team bewust zijn van alle aspecten met betrekking tot de taakuitvoering en teamsamenwerking.

Hoofdstuk 4 omvat de rapportage over vier case studies en een cross-case analyse die werden uitgevoerd om het belang van de drie belangrijkste variabelen (*shared mental models*, *mutual trust*, en *mutual performance monitoring*) in de verschillende fases van teamsamenwerking nader te verkennen en de vier leerteams te vergelijken in hun teamontwikkeling en het ontstaan van teameffectiviteit. In de studie werd het proces van teamontwikkeling en samenwerking voornamelijk onderzocht vanuit een *insider* perspectief door het gebruik van online vragenlijsten en het interviewen van de teams. De opbrengsten bevestigen het belang van *task and team awareness* om effectief te worden als leerteam, en daarmee de betekenis van het ontwikkelen van een gedeelde visie op de taakuitvoering (*task-related shared mental models*) en teamsamenwerking (*team-related shared mental models*) in een vroeg stadium van het proces. Een basis van onderling vertrouwen (*mutual trust*) is voorwaardelijk om de beide *shared mental models* te ontwikkelen. Een leerteam dient daarnaast de aandacht te verdelen over de taakuitvoering en teamsamenwerking en dient taakgerelateerde en teamgerelateerde vaardigheden te ontwikkelen. Beide type vaardigheden moeten worden gecombineerd om productief te worden als team. Leerteams doorlopen vaak een transitiefase waarin ze de strategie met betrekking tot de taakuitvoering en teamsamenwerking aanpassen om de productiviteit verder op te voeren en om zodoende een eindresultaat op te leveren voordat de deadline verstrijkt. Wellicht kan een beperkte onevenwichtigheid in deze vaardigheidsontwikkeling nog gerepareerd worden in de transitiefase, mits beide type *shared mental models* eerder al voldoende werden ontwikkeld en er sprake is

van een basis van onderling vertrouwen, want alleen dan kan een leerteam de strategie aanpassen en de teamrollen herdefiniëren om nog effectief te worden in de laatste productieve fase. Een leerteam dat aandacht heeft voor het eigen functioneren op zowel taakniveau als teamniveau, wordt eerder in het proces effectief en hoeft in de transitiefase maar kleine aanpassingen te verrichten om nog doelgerichter te kunnen opereren.

In hoofdstuk 5 wordt ingegaan op dezelfde vier case studies, maar nu wordt vooral vanuit het *outsider* perspectief gekeken naar de wijze waarop de variabelen een rol spelen in de teamontwikkeling en het ontstaan van effectiviteit in de verschillende fases van de samenwerking. Hiertoe is de teamcommunicatie binnen de verschillende teams geanalyseerd en met elkaar vergeleken. Dit geeft inzicht in de manier hoe de teamgerelateerde en taakgerelateerde vaardigheden door de verschillende teams worden gecombineerd en wat daarvan de gevolgen zijn voor de ontwikkeling als team. Gedurende het hele project werd de communicatie in teamvergaderingen opgenomen met voice recorders. Door de resultaten van de analyse van de teamcommunicatie te verbinden met wat uit de teaminterviews werd vastgesteld is een dieper inzicht ontstaan in de ontwikkeling van de teams. De opbrengsten bevestigen alle bevindingen uit de voorgaande studies, respectievelijk het belang van het ontwikkelen beide *shared mental models* in een vroeg stadium, de betekenis van *mutual trust* om die *shared mental models* te kunnen ontwikkelen, de taakgerichtheid van leerteams en hun pragmatisme, en het feit dat teams die de *shared mental models* al in een vroeg stadium hebben ontwikkeld hun strategie maar beperkt hoeven bij te stellen in de transitiefase. Een team dat geen overeenstemming heeft bereikt over de doelen en strategie in een vroeg stadium zal de discussie hierover in de transitiefase opnieuw moeten voeren, maar dat zal waarschijnlijk alleen leiden tot een *task-related shared mental model* als er al wel een *team-related shared mental model* werd ontwikkeld, daar dit voorwaardelijk lijkt te zijn voor het nemen van besluiten over een herverdeling van rollen en taken en voor het aanpassen van de *mutual performance monitoring*. Een onvoldoende ontwikkeld *team-related shared mental model* interfereert ook met de teamcommunicatie en kan de aanleiding zijn voor mis-

communicatie en conflicten als gevolg van onwetendheid over de expertise en voorkeuren van de teamleden. In een team waarin beide *shared mental models* niet werden ontwikkeld voorafgaand aan de transitiefase, kan tijdens de transitiefase een vorm van autoritair leiderschap ontstaan waarbij een teamlid de macht naar zich toe trekt en nieuwe procedures dicteert om alsnog een product op te leveren voor het verstrijken van de deadline.

In hoofdstuk 6 wordt gerapporteerd over twee case studies en een cross-case analyse die werden uitgevoerd in een andere context waarbij enkele beperkingen van de vier voorgaande case studies konden worden opgelost, zoals de leeftijdsverschillen tussen teamleden binnen een leerteam en verschillen tussen de opdrachten. De beide teams in deze case studies hebben vrijwel dezelfde samenstelling en werken gedurende een semester aan precies dezelfde opdracht. Het *insider* en *outsider* perspectief werden in dit geval gecombineerd door een korte vragenlijst voor te leggen in drie fases, door de beide teams te interviewen, en door de teamcommunicatie te analyseren, met als doel inzicht te verkrijgen in welke rol de variabelen hebben met betrekking tot het ontstaan van teameffectiviteit in het perspectief van de ontwikkeling van een team. Daarnaast werden de effecten van de interventies van de begeleider (tutor) geanalyseerd. De bevindingen uit de voorgaande case studies en cross-case analyse werden bevestigd, maar ook werd vastgesteld dat een vorm van leiderschap kan ontstaan in een effectief leerteam dat is gebaseerd op de leiderschapskwaliteiten van één van de teamleden, als die worden erkend door de andere teamleden. Dit impliceert dat het team reeds een *task-related shared mental model* en een *team-related shared mental model* heeft ontwikkeld en er sprake is van voldoende *mutual trust*. Het betreft hier een vorm van gecentraliseerd leiderschap van tweede orde dat verbonden is aan de taakuitvoering en zich ontwikkelt uit het gedeeld leiderschap van eerste orde waarvan sprake dient te zijn in een eerdere fase van het proces. Interessant is de vraag of een dergelijk type leiderschap ook kan ontstaan in een ineffectief leerteam, maar waarschijnlijker is dat daar een vorm van leiderschap ontstaat die weinig democratisch zal zijn om het hoofd te bieden aan de kritieke situatie en een snel naderende deadline waarop resultaten geleverd moe-

ten worden. Echter, wanneer een ineffectief team ook nog kampt met conflicten, dan is de behoefte aan een teamleider van het type mediator wellicht groot zodat daarmee de conflicten kunnen worden opgelost. De case studies lieten ook zien dat de leden van een effectief leerteam elkaar eveneens buiten formele vergaderingen ontmoeten en met elkaar omgaan, wat wellicht compenseert voor het feit dat teams in die formele vergaderingen overwegend taakgericht communiceren. Daardoor kan het leerteam toch een *team-related shared mental model* ontwikkelen. De wijze waarop interventies van een tutor worden ervaren hangt af van de ontwikkeling van een team. Een gerijpt leerteam zal geneigd zijn de taakuitvoering en teamsamenwerking volledig zelf te sturen, terwijl een minder ontwikkeld team zich wellicht meer afhankelijk opstelt ten aanzien van de tutor en ondersteund wil worden bij de taakuitvoering en teamsamenwerking, met name als leiderschapskwaliteiten in het team ontbreken.

Dit onderzoek heeft bijgedragen aan het begrip van de dynamiek van samenwerking in de praktijk van het samenwerkend leren in het hoger onderwijs, en meer specifiek aan het inzicht in welke factoren gedurende het hele proces van samenwerken van invloed zijn op de effectiviteit van leerteams. Het ontwikkelde model kan benut worden bij nog uit te voeren onderzoek naar de effectiviteit van teams bij samenwerkend leren omdat daarin verschillende theorieën over groepsontwikkeling worden geïntegreerd binnen een model dat gericht is op de ontwikkeling van leerteams. Dit ontwikkelingsmodel levert een raamwerk op voor het positioneren en bespreken van variabelen die van invloed zijn op de teameffectiviteit. Het onderzoek resulteerde tevens in een gevalideerde vragenlijst voor het meten van de variabelen die teameffectiviteit beïnvloeden en van de ervaren teameffectiviteit. Dit instrument kan in toekomstig onderzoek naar samenwerkend leren in het hoger onderwijs gebruikt worden. Er werd eveneens een korte vragenlijst uit afgeleid en deze is in alle case studies getest. Op termijn kan die worden doorontwikkeld tot een valide en betrouwbaar instrument voor het meten van de gepercipieerde teameffectiviteit in verschillende fases van het proces om daarmee de ontwikkeling van een team op een efficiënte wijze in beeld te brengen. Dat kan ook van waarde zijn voor toekomstig onderzoek en mogelijk

ook voor tutoren of begeleiders om op basis daarvan te bepalen welke interventie in een gegeven situatie effectief kan zijn.

Het onderzoek levert ook handreikingen op voor de onderwijspraktijk in de vorm van een aantal richtlijnen voor het effectief organiseren, begeleiden en beoordelen van samenwerkend leren in het hoger onderwijs. Een opdracht voor samenwerkend leren moet complex zijn zodat samenwerken noodzakelijk is, en teamleden moeten daarbij afhankelijk zijn van elkaar zodat dat een opdracht niet individueel moet kunnen worden afgerond. En opdracht dient ook een open karakter te hebben en gericht te zijn op het ontwikkelen van een oplossing of product, wat impliceert dat er kennis ge(re)construeerd moet worden. Bij elke nieuwe opdracht in een ander leerteam dienen studenten de teamvaardigheden en taakvaardigheden opnieuw te ontwikkelen, omdat deze vaardigheden in hoge mate specifiek zijn voor een bepaald team en een specifieke taak. Leerteams hebben mede daardoor maatwerk in begeleiding nodig om effectief te worden, zowel naar taakuitvoering als naar teamsamenwerking. De opdrachten zijn immers leertaken, waarbij de studenten nog maar beperkte expertise bezitten en zich daarom nog geen volledig beeld kunnen vormen van de mogelijke leerresultaten van de samenwerking. Ook dienen zowel de gemeenschappelijke producten van de samenwerking als de individuele bijdragen van teamleden te worden beoordeeld om de teamgerichtheid te versterken en om studenten te stimuleren bij te dragen aan de taakuitvoering en teamsamenwerking. Het onderschatten van de complexiteit van samenwerkend leren en van het belang van het goed ondersteunen van dit type leren kan tot gevolg hebben dat de studenten geen toegevoegde waarde zien in samenwerkend leren. Studenten ervaren samenwerkend dan als negatief en contraproductief, wat bij hen tot verdere daling van teamgerichtheid kan leiden.

Dit onderzoek heeft enige beperkingen. Alleen de kernaspecten van het model werden getest en vervolgonderzoek is noodzakelijk om het hele model te valideren. Daarnaast werd de effectiviteit van leerteams vooral gemeten met behulp van zelfrapportage. In de toekomst dient daarbij de externe beoordeling van resultaten van samenwerkend leren meegewogen te worden. Diepgaande leerresultaten kunnen immers het gevolg zijn van tijdrovende en moge-

lijk inefficiënte discussies en onderhandelingen, hetgeen tegelijkertijd kan leiden tot relatief lage scores op ervaren teameffectiviteit. Ten slotte, de case studies kenden beperkingen ten aanzien van de teamsamenstelling, het type leeropdrachten en de kenmerken van de studenten en dat impliceert generaliseren van de bevindingen niet mogelijk is en de conclusies met voorzichtigheid dienen te worden geïnterpreteerd.

Er zijn veel mogelijkheden voor vervolgonderzoek, gegeven de complexiteit van de ontwikkeling van effectieve leerteams vanwege het aantal en het samenspel van variabelen die invloed hebben op die ontwikkeling. Het complexe construct *mutual trust* en kenmerken van *back-up behavior* en *adaptablity* bij samenwerkend leren verdienen nader onderzoek. De case studies dienen op grotere schaal in verschillende educatieve contexten gerepliceerd te worden om de bevindingen uit dit onderzoek te valideren. Tevens dienen de effecten van interventies door tutoren op de ontwikkeling van leerteams diepgaander verkend te worden, evenals de effecten van verschillende opdrachten en beoordelingsprocedures op de houding van studenten ten aanzien van samenwerkend leren.

Opdrachten tot samenwerkend leren in het hoger onderwijs, en meer specifiek in de context van het hoger beroepsonderwijs, kunnen worden getypeerd naargelang ze op productontwikkeling of kennisconstructie gericht zijn. Bij productontwikkeling is kennis construeren een afgeleide en dit type leerteams is tot op zekere hoogte vergelijkbaar met projectgroepen in werksituaties en dan gelden vergelijkbare procedures voor de teamsamenwerking, taakuitvoering en kwaliteitszorg. Het verschil is echter dat leden van een leerteam nog geen gedetailleerd beeld kunnen hebben van de resultaten van dat leerproces en dat het hen ontbreekt aan de macht en de middelen om invloed uit te oefenen op de omgeving. Dat betekent dat samenwerkend leren in deze context goed moet worden georganiseerd en dat leerteams adequaat dienen te worden begeleid en ondersteund om effectief te worden als team.

Curriculum Vitae

Jos Fransen (Johannes Joseph Marcus Maria Fransen) was born in **Enschede** in the Netherlands on April 25, 1954.

Work | Jos Fransen is lecturer in the Master program *Learning & Innovation* at the Faculty of Education of Inholland University of Applied Sciences. As an educational staff member he also was involved in the development of the curriculum of the Master program with respect to the pedagogical approach, learning content, and the design of the electronic learning environment. As senior research fellow he is participating in several research projects of the Centre for eLearning of Inholland University, covering aspects of the acceptance, implementation and transfer of technology supported learning, and in research projects investigating students' perceptions of learning with technologies.

He started his career in higher education in 1990 as a music teacher in the Bachelor Program on Cultural Education and Community Development at the Faculty of Social Studies. Before starting a career in higher education he was respectively music teacher and workshop leader in a youth penitentiary institute in Amersfoort and youth social worker in a community centre in The Hague.

Education | Jos Fransen finished high school in 1972 and started studying Medicine at the Ghent University in Belgium. He received his Bachelor Degree in 1975, but decided to change his career perspective. Combining several jobs with education he attended courses in woodwork, respectively Furniture Making and Guitar Making. In 1980 he started in the Music Teaching program at the Rotterdam Conservatory, and obtained a First-level Degree in Music Teaching in 1985. He combined a job as music teacher and workshop leader with part-time education and attended the Visual Arts program at the Willem de Kooning Art Academy in Rotterdam until 1990.

He supplemented his education by taking a course in Sound Recording at the Media Institute in Hilversum, several courses on Curriculum Development, a course in Project Management and a post-graduate course in Cultural Education. He also took a course in Creative Writing and followed Master Classes in Creative Writing. Due to a change in position at the Inholland University, he started the Master program on Educational and Training Systems Design at the University of Twente in 2000, and obtained a Master of Science Degree (cum laude) in 2004 with research on e-tutor competencies.

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